THE MARINERS
PLAIN SCALE
NEW PLAIN'D:

The Third PART or BOOK.

Shewing the Uſes of a Line of CHORDS onely, in Reſolving or Projecting all the 28 Caſes of Sphærical Triangles on the Stereographick or Circular Projection.

Alſo how from three Shadows of a Wyre on a Horizontal Plain, taken the ſame day, to finde the Latitude of the Place, the Suns Declination, *&c.*

Whence follows a general Method of Dyalling from three Shadows, or by help of two Shadows, *&c.* With other Propoſitions of excellent Uſe to Sea-men and Practitioners in the Mathematicks.

Being contrived to be had either alone, or with the other Parts.

Written by John Collins *of* London, *Pen-man, Accomptant.* Philomathet.

LONDON:
Printed by *Tho. Johnſon* for *Francis Coſsinet*, and are to be ſold at the Anchor and Mariner in *Tower-ſtreet*, and by *Hen. Sutton* Mathematical Inſtrument-maker in *Thread-needle-ſtreet*, behinde the *Royal Exchange*. 1659.

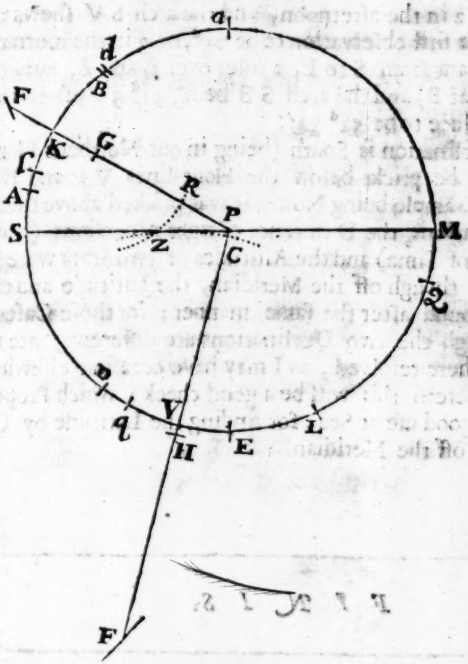
Another Proposition like this, and performed after the same maner, is:

To give the Suns Declination, two Altitudes with the difference of Time between them, to finde the Latitude of the place, and the respective times of the day, answering to those Observations.

Declination $23^d\ 31'$ North.

Altitudes { the lesser $27^d\ 23'$. the greater $53^d\ 45'$.

Difference of time 7 hours, or 105^d.



Having upon P as a Center, with 60^d of the Chords, described a Circle, draw a Line into the Center as V P produced, to represent the first hour, and set off 105 degrees, the difference of time from V to K, and draw K P produced, then set off a quadrant or 90^d, from V to Q, also from K to *q*, then prick off the Suns Declination $23^d\ 31'$ from V to D, also from K to *d*, and prick off the complement of the lesser Altitude, to wit, $62^d\ 37'$ from D to A and L, a ruler over Q and A, cuts P V at C; also a ruler over Q and L, cuts the said Line produced at F, the half be-

between F and C is at H, with the extent H C, upon H as a Center, deſcribe the ark C Z.

Again, prick off the complement of the leſſer Altitude, to wit, 36ᵈ 15′ from *d* to *a* and *l*, a ruler over *q* and *a*, cuts K P at R, alſo a ruler over *q* and *l*, cuts P K produced at F, the half between F and R is at G, with the extent G R, upon G and a Center, deſcribe the ark R Z; where theſe arks interſect, as at Z, is the Zenith, draw the line S M paſſing through the ſaid Interſection and the Center, and it ſhall repreſent the hour-line of 12, the arch S K ſhews the hour to the greater Altitude to be 30ᵈ from the Meridian, or 2 in the afternoon, and the arch S V ſhews the hour proper to the firſt obſervation to be 75ᵈ, or 7 in the morning.

Set off a quadrant from S to E, a ruler over E and Z, cuts the primitive Circle at B, and the arch S B being 51ᵈ 32′, ſhews the Latitude of the place to be 51ᵈ 32′.

When the Declination is South (being in our Northern Hemiſphere) it muſt be prickt below the Hour-lines V P and K P, whereas in this Example being North, it was pricked above them; Or if the Declinations, the Difference of right Aſcenſions (which is the difference of Time) and the Altitudes of two Stars were given at any time, though off the Meridian, the Latitude and true time might be found after the ſame manner; for thoſe Caſes of Triangles (though the two Declinations are different) are the ſame with thoſe here reſolved, as I may have occaſion elſewhere to calculate, whereto this will be a good check; which Propoſitions may be of good uſe at Sea, for finding the Latitude by Obſervations taken off the Meridian.

FINIS.

THE SEAMANS SECRETS.

Devided into two Parts.

WHEREIN IS TAUGHT the three kindes of Sayling, Horizontal, Paradoxal, and Sayling upon a Great Circle.

Also an Horizontal Tyde-Table for the easie finding of the Ebbing and Flowing of the Tydes, with a Regiment newly Calculated for the finding of the Declination of the Sun, and many other most necessary Rules and Iustruments, not heretofore set forth by any.

Newly Corrected and amended, and the Eighth time Imprinted.

LONDON,
Printed by *Gartrude Dawson*, living in *Bartholomews* Close, the second door from the *Half Moon* Tavern's Alley that goes into *Aldersgate*-street, 1657.

BIBLIOTHECA·BODLEIANA

To the right honorable Lord, CHARLES HAWARD, Baron of *Effingham*, Knight of the noble Order of the Garter, Lieutenant of her Majesties Counties of *Sussex* and *Surrey*, Constable of her Majesties Honour and Castle of *Winsor*, Lord high Admiral of *England*, *Ireland*, and *Wales*, and of the Dominions and Isles of the same, of the Town of *Callis* and Marches thereof, *Normandy*, *Gascony*, and *Greyves*, Captain General of her Majesties Seas and Navie Royal, and one of her Majesties most Honourable privie Councel, *John Davis* wisheth encrease of Honour, and perfect felicity.

RIght Honourable, and my special good Lord as by the instinct of nature, all men are desirous of knowledge, and take pleasure in the varieties of understanding, so it is likewise ingrafted by the same benefit of nature, in the hearts of true Nobility, not only to excel the vulgar sort, but also to cherish, support, and countenance all such as shall in due course prosecute their vocation; and as such practises either speculative or mechanical, shall receive favourable place in the honourable opinion of Nobility, by so much the more shall the practiser be esteemed: which is the cause that at this time emboldeneth me to present unto your most Honorable favour this small Treatise of Navigation, being a brief collection of such practises as in my several voyages I have from experience collected. Among which in three several attempts for the discovery of the Northwest passage, thereby to find a short and Navigable course unto the rich and famous Countries of *Cathyo China*, *Pegu*, the Isles *Molucan* and *Phillipina*, that thereby to the great and inestimable benefit of our Country, there might be a rich and plentiful trade procured between us and the said Nations, in short time to be performed, and with great safety in regard of the course: which action and discovery (by means of that honorable Counseller, Sir *Francis Walsingham*, Knight, principal Secretary to her Majesty) was with a good resolution accepted by the Merchants of *London*, but in the

decay of his honourable life, the attempt was likewiſe quailed: but howſoever mens minds alter, yet undoubtedly there is paſſage Navigable, and eaſie to be performed by that courſe (whenſoever it ſhall pleaſe God to reveal the ſame) by invincible reaſons and ſufficient experience to be proved: and although before I entred into that diſcovery, I was ſufficiently perſwaded of the certainty thereof, by hiſtorical relation, ſubſtantially confirmed, whereof to the Adventures I made ſufficient proof, but eſpecially to my worſhipful good friend Mr. *William Sanderſon*, the only Marchant that to his great charges, with moſt conſtant travel, did labour for the finiſhing thereof: yet I thank God that of late it hath been my very good chance, to receive better aſſurance than ever before of the certainty of that paſſage, and ſuch was my vehement deſire for the performance therof, that thereby I was only induced to go with M. *Candiſh* in his ſecond attempt for the *South* Seas, upon his conſtant promiſe unto me, that when we came to the *Californa*, I ſhould there have his Pinnace with my own Bark (which for that purpoſe went with me to my great charges) to ſearch that Northweſt diſcovery upon thoſe back parts of *America*, but God hath otherwiſe diſpoſed our purpoſes in his divine judgements, for Mr. *Candiſh* being half way through the Straits of *Magilane*, and impatient of the tempeſtuous furiouſneſſe of that place, having all his Ships and company with him, returned for *Braſil*, by the authority of his command, when with a leading wind we might have paſſed the ſame, and returning more than 80. leagues toward *Braſil*, my ſelf being in his Ship named the *Deſire* without Boat, Oares, Sails, Cables, Cordage, Victuals, or health of my Company ſufficient for that attempt, was ſeparated in a freit of weather, and forced to ſeek the next ſhore for my relief, & recovering a Harborow by us named *Port Deſire*, being in the latitude of 48 degr. did there repair my moſt miſerable wants, and there ſtaying four months in moſt lamentable diſtreſſe did again conclude with my Company, to give another attempt to paſſe the Straits, as my beſt mean to gain relief. And three times I was in the *South* Seas, but ſtill by furious weather forced back again: yet notwithſtanding all this my labour to perform the voyage to his profit, and to ſave my ſelf (for I did adventure, and my good friends for my ſake, 1100. pounds in the action) Mr. *Candiſh* was content to account me to be the Author of his overthrow, and to write with his dying hand that I ran from him, when that his own Ship was returned many months before me.

I am

I am bold to make this Relation unto your Lordſhip, only to ſatisfie your Honour of my converſation, for were I faulty of ſo foul a crime, I were worthy of ten thouſand torments, in preſuming to preſent this Treatiſe to your Honourable Lordſhip, and now refering my cauſe to your Lordſhips conſideration, I will again return to my purpoſe.

In thoſe Northweſt voyages, where Navigation muſt be executed in moſt exquiſite ſort, in thoſe attempts I was enforced to ſearch all poſſible means required in ſayling, by which occaſion I have gathered together this brief Treatiſe, which with my ſelf I do dedicate to your honourable protection, being deſirous if it lay in my power to do far greater matters in your Lordſhips ſervice, hoping of your honorable pardon, becauſe it is only done to ſhew my dutiful affection, and not for any ſingularity that the work containeth. For I think there be many hundreds in *England* that can in a far greater meaſure and more excellent method expreſſe the noble art of Navigation, and I am fully perſwaded that our Country is not inferiour to any for men of rare knowledge, ſingular explication, and exquiſite execution of the Arts Mathematick, for what ſtrangers may be compared with Mr. *Thomas Digs* Eſquire, our Country-man the great Maſter of Arch maſtry, and for Theorical ſpeculations and moſt cunning calculation, Mr. *Dee* and Mr. *Thomas Heriotts* are hardly to be matched: and for the mechanical practiſes drawn from the Arts of Mathematick, our Country doth yield men of principal excellency, as Mr. *Emery Mulleneux* for the exquiſite making of Globes-bodies, and Mr. *Nicholas Hellyar* for the ſingularity of portraicture, have the praiſe of *Europe*, Mr *Baker* for his skill and ſurpaſſing grounded knowledge for the building of Ships advantageable to all purpoſes, hath not in any Nation his equal.

And now that I may return to the painful Seaman, it is not unknown unto all Nations of the Earth, that the *Engliſh* goeth before all others in the practiſes of Sayling, as appeareth by the excellent diſcovery of Sir *Francis Drake* in his paſſages through the Straits of *Magilane*, which being then ſo raſhly known, he could not have paſſed, unleſſe he had been a man of great practice and rare reſolution: ſo much I may boldly ſay, becauſe I have ſeen and taſted the frowardneſſe of the place, with the great unlikelihood of any paſſage to be that way.

I might here repeat the moſt valiant and excellent attempts of Sir *Hugh*

Hugh Willoughbie, Sir *John Hawkins*, Sir *Humphry Gilbert*, and your Lordſhips ſervant Mr. *George Raymond*, with divers others that have given moſt reſolute attempts in the practiſes of Navigation, as well for the diſcovery as other execution, whereby good proof is made, that not only in the skill of Navigation, but alſo in the mechanical execution of the practiſes of ſayling, we are not to be matched by any Nation of the earth.

And ſith Navigation is the mean whereby Countries are diſcovered and community drawn between Nation and Nation, the Word of God publiſhed to the bleſſed recovery of the forreign off caſts, from whence it hath pleaſed his divine Majeſty as yet to detain the brightneſs of his glory: and that by Navigation Common-weales through mutual trade are not only ſufficiently ſuſtained, but mightily enriched; with how great eſteem ought the painful Seaman to be embraced, by whoſe hard adventures ſuch excellent benefits are atchieved, for by his exceeding great hazards the form of the earth, the quantities of Countries, the diverſity of Nations, and the natures of Zones, Climats, Countries and people, are apparently made known unto us. Beſides, the great benefits mutually interchanged between Nations, of ſuch fruits, commodities, and artificial practiſes, wherewith God hath bleſſed each particular country, coaſt, and Nation, according to the nature and ſcituation of the place.

For what hath made the *Spaniard* to be ſo great a Monarch, the commander of both *Indias*, to abound in wealth & all natures benefits but only the painful induſtry of his ſubjects in Navigation, their former trade was only figs, oringes, and oyl, but now through Navigation is brought to be gold, ſilver, pearls, ſilks, and ſpice, by long and painful trade recovered. Which great benefits only by her Majeſties loving clemency and merciful favour he doth poſſeſſe: for if her Highneſſe and her moſt honorable Lords would not regard the ſmall diſtance between her Dominions and thoſe famous rich Kingdoms, the eaſineſſe of the paſſage being once diſcovered (the North-weſt I mean) with the full ſufficiency of her Highneſſe ſubjects to effect the ſame, there could then be no doubt, but her ſtately ſeat of *London* ſhould be the ſtore-houſe of *Europe*, and a nurſe to all Nations, in yielding all *Indian* commodities in a far better condition, at a more eaſie rate than now brought unto us, exchanging commodities of our own ſtore, with a plentiful return at the firſt hand, which now by many exchanges are brought unto us.

Then

Then ſhould the *Spaniard* again return to his old trade, and our Sacred Sovereign be ſeated the Commander of the earth: which trade and moſt fortunate diſcovery, we above all nations ought moſt principally to regard, becauſe of the ſingularity and invincible force of our Shipping, which is not only the commanding Fortreſſe of our Country, but alſo the dread of our Adverſary, and the glory of our Nation: wherein we do in no ſort flatter our ſelves, for it was made apparent to all Nations of the earth, by the late moſt famous conqueſt that her Majeſty had againſt the huge ſuppoſed invincible Fleet of the *Spaniard*, being by her Navie under the command o your Lordſhip, who there in perſon and in place of her Majeſty, to your eternal glorious fame did diſgrace their glory and confound their force, and manifeſt their weakneſſe by their daſtardly flight, through Gods providence and your Lordſhips ſtately reſolution.

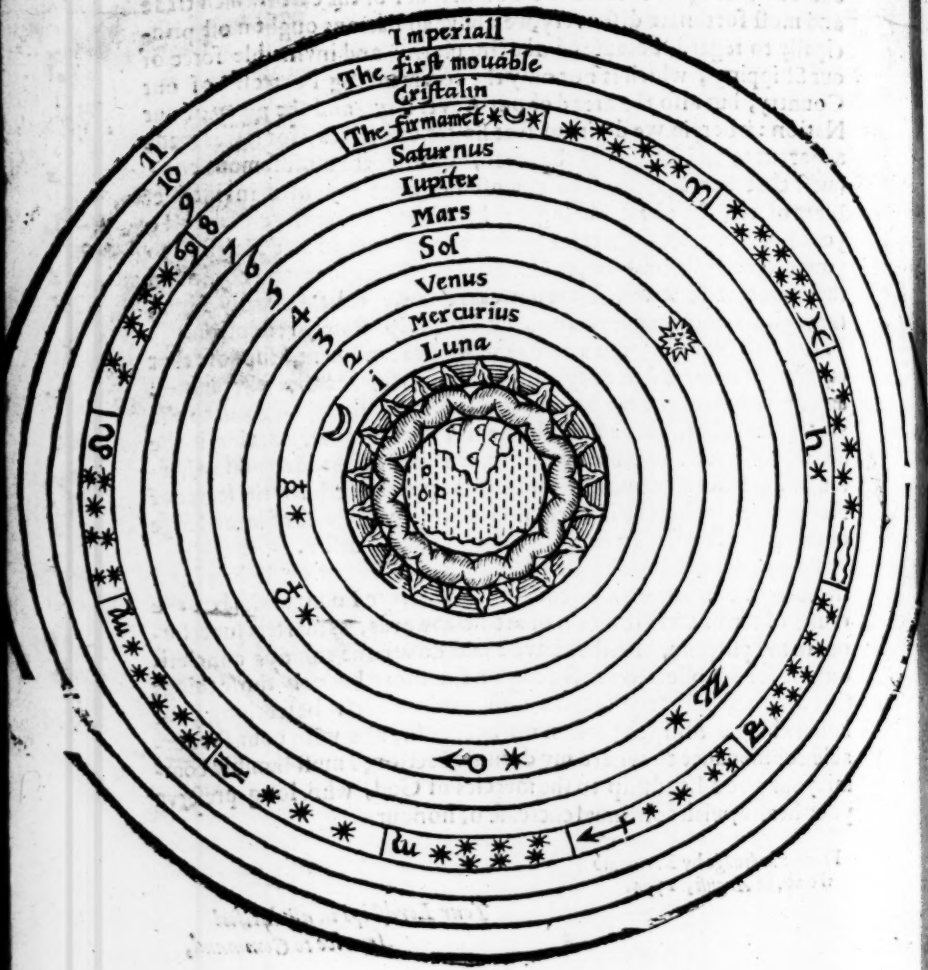
Then ſith Navigation is a matter of ſo great moment, I ſuppoſe that every man is bound in duty to give his beſt furtherance thereunto: among whom as the moſt unmeet of all, yet wiſhing all good to the painful traveller, I have publiſhed this ſhort Treatiſe, naming it the *Seamans Secrets*, becauſe by certain queſtions demanded and anſwered, I have not omitted any thing that appertaineth to the ſecret of Navigation, whereby if there may grow any encreaſe of knowledge or eaſe in practice, it is the thing which I chiefly deſire.

To manifeſt the neceſſary concluſions of Navigation in brief and ſhort terms, is my only intent, and therefore I omit to declare the cauſes of terms and difinition of artificial words, as matters ſuperfluous to my purpoſe, neither have I laid down the cunning concluſions apt for Schollers to practice upon the ſhore, but only thoſe things that are needfully required in a ſufficient Seaman: beſeeching your honorable Lordſhip to pardon my boldneſſe, and with your favourable countenance to regard my dutiful affection, I muſt humbly commit your good Lordſhip to the mercies of God, who long preſerve your health, with continual encreaſe of honour.

From *Sandrudge* by *Dartmouth* the 20. of *Auguſt*, 1594.

Your Lordſhips in all dutiful ſervice to Command,

JOHN DAVIS.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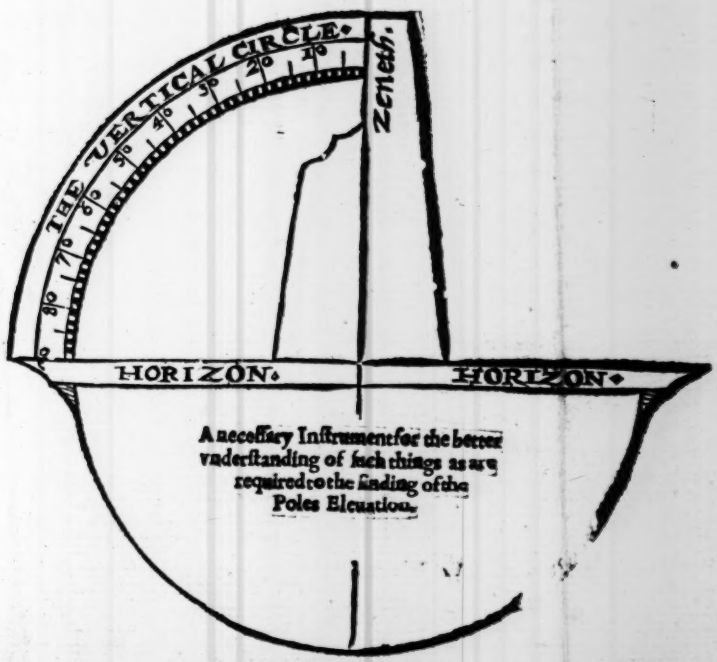
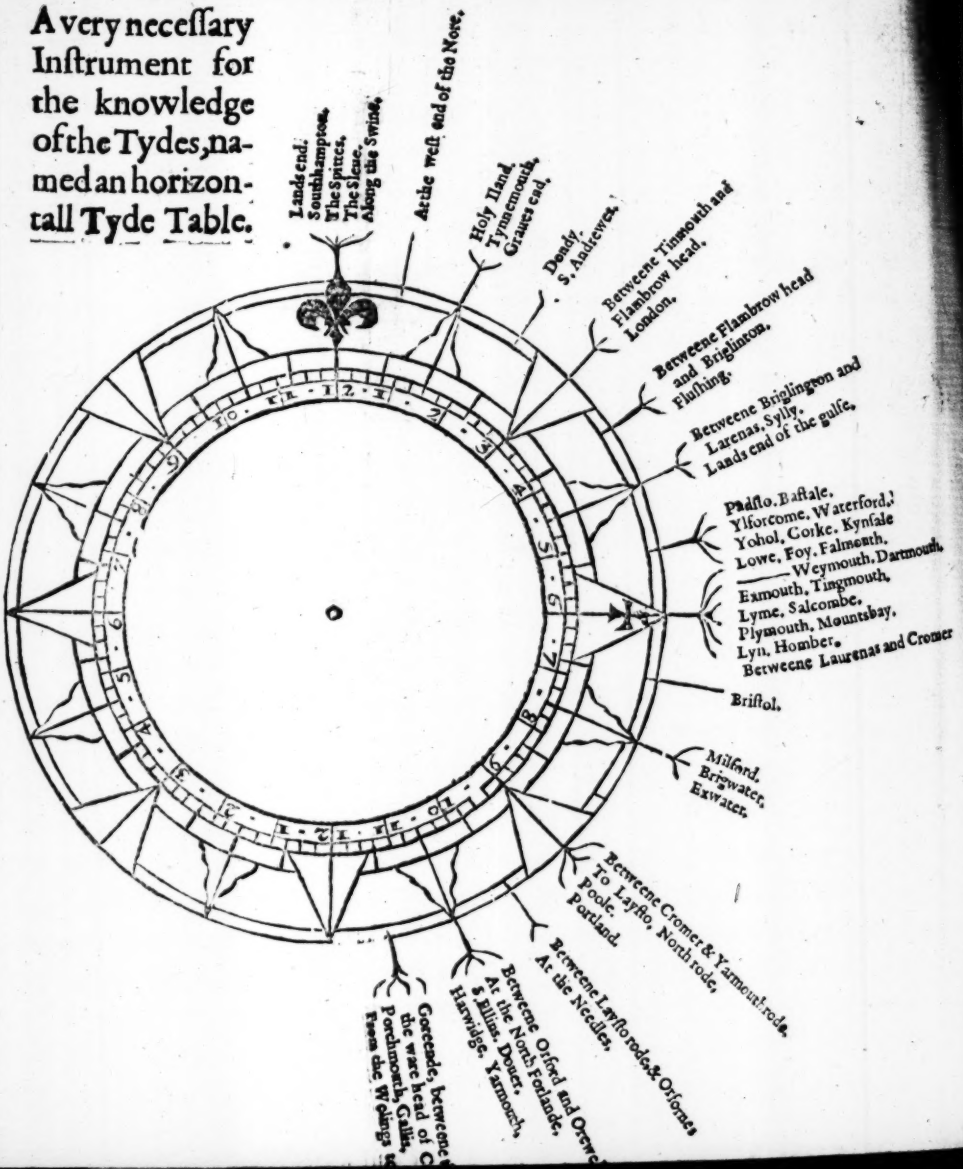


A necessary Instrument for the better vnderstanding of such things as are required to the finding of the Poles Elevation.

A very neceſſary Inſtrument for the knowledge of the Tydes, named an horizontall Tyde Table.



THE FIRST BOOK OF THE *SEAMANS SECRETS.*

What is Navigation?

NAvigation is that excellent Art, which demonstrateth by infallible conclusions, how a sufficient Ship may be conducted the shortest good way from place to place, by Coyle and Travers.

What are these infallible Conclusions?

NAvigation consisteth of three parts, which being well understood and practised, are Conclusions infallible, whereby the skilful Pilote is void of all doubt to effect the thing purposed. Of which, the first is the Horizontal Navigation, which manifesteth all the varieties of the Ships motion within the Horizontal plain superficies, where every line drawn is supposed a parallel.

The second is a Paradoral, or Cosmographical Navigation, which demonstrateth the true motion of the Ship upon any Course assigned in longitude, latitude, and distance, either particular or general, and is the skilful gathering together of many Horizontal Coyles, into one infallible and true motion Paradoral.

The third is a great Circle Navigation, which teacheth how upon a great Circle, drawn between any two places assigned, (being the only shortest way between place and place) the Ship may be conducted, and

is perfourmed by the skilful application of Horizontal, and Paradoxal Navigation.

What is a Corse?

A Corse is that Paradoxal line which passeth betwæn place & place, according to the true Horizontal position of the Magnet, upon which line the Ship prosecuting her motion, shall be conducted betwæn the said places.

What is a Travers?

A Travers is the variety or alteration of the Ships motion upon the shift of Winds within any horizontal plain superficies, by the good collection of which Traverses, the Ships uniform motion or Corse is given.

What instruments are necessary for the execution of this excellent skill?

THe Instruments necessary for a skilful Seaman, are a Sea Compas, a Cross-staff, a Quadrant, an Astrolaby, a Chart, an Instrument Magnetical for the finding of the variation of the Compas, an Horizontal plain Sphære, a Globe, and a Paradoxal Compas. By which Instruments, all conclusions and infallible demonstrations, Hydrographical, Geographical, and Cosmographical, are without controlement of error to be perfourmed: But the Sea Compas, Chart, and Cross-staff, are instruments sufficient for the Seamans use: the Astrolaby and Quadrant being Instruments very uncertain for Sea-Observations.

What is the Sea Compas?

THe Sea Compas, is a principal Instrument in Navigation, representing and distinguishing the Horizon, so that the Compas may conveniently be named an Artificial Horizon, because by it are manifested all the limits and distinctions of the Horizon, required to the perfect use of Navigation, which distinctions are the 32 points of the Compas, whereby the Horizon is divided into 32 equal parts, and every of those points hath his proper name, as in the Figure following appeareth. Also every Point of the Compas doth contain Degrees, Minuts, Seconds, and Thirds, &c. Which Degrees are called degrees of Azumuth, whereof there are in every point 11 ¼ so that the whol Compas or Horizon containeth 360 degrees of Azumuth, for if you multiply 11 ¼ degrees, the degrees that each point containeth, by 32 the points of the Compas, it yeldeth 360 the degrees of the Compas. And of minuts each point containeth 45 being ¼ of an hour, so that the whole Compas is hereby divided into 24 hours, by which accompt there are in an hour 15 degrees, so that every degree containeth 4 minuts of time, for an hour consisting of 60 minutes hath for his fifteenth part 4 minutes of time, and in every minute there is sixty seconds, and

every

every second containeth fifty thirds, either in degrees applied to time, or degrees applied to measure: so that the general content of the Compass is 32 points, 365 degrees, and 24 hours, with their minutes, seconds, and thirds.

What is the use of the 32 Points of the Compass?

THe use of the 32 points of the Compass, is to direct the skilful Pilote by Horizontal Travers, how he may conclude the Coxe or Paradoxal motion of his Ship, thereby with the greater expedition to recover the place desired, because they divide the Horizon in such limits as are most apt for Navigation, they do also distinguish the Winds by their proper Names, for the Wind receiveth his name by that part of the Horizon from whence it bloweth.

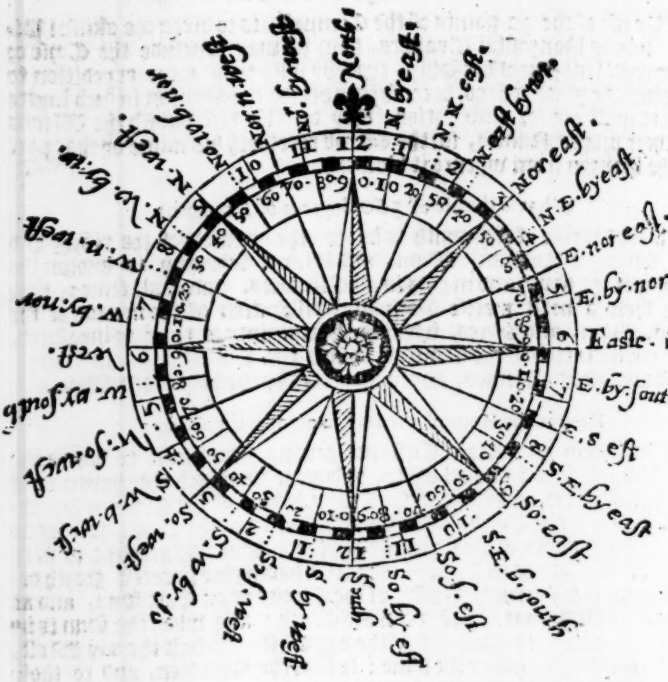
What is the use of 360 degrees of Azumuth?

BY the degrees of Azumuth is known the quantity of the rising and setting of the Sun, Moon, and Stars, whereby is known the length of the dayes and nights in all Climates, and at all times; they also shew a most precise Horizontal distinction of the motion of the Sun, Moon, and Stars, whereby the certainty of time is measured, and the variation of the Compass, with the Poles height, is ingeniously known at all times, and in all places by the help of the Globe.

How is the Hour of the Day known by the Compass?

IT hath been an ancient Custome among Mariners, to divide the Compass into 24 equal parts, or hours, by which they have used to distinguish time, supposing an East Sun to be 6 of the Clock, a South-east Sun 9 of the Clock, and a South Sun 12 of the Clock, &c. as in the Figure following shall plainly appear. But this account is very absurd, for with us in England (the Sun having his greatest North declination) it is somewhat past 7 of the Clock, at an East Sun, and at a South-east Sun it is past 10 of the Clock: also when the Sun is in the Equinoctial, the Sun is half the day East, and half the day West, to all those that be under the same: so that the Sun then, and to those people useth but two points of the Compass, to performe the motion of 12 hours: therefore the distinctions of time may not well be given by the Compass, unless the Sun be upon the Meridian, or that you be far toward the North, in such places where the Suns Horizontal motion is very oblique, for there the hour may be given by the Compass without any great error, but else-where it cannot. Therefore those that travel must either use the Globe, or an Equinoctial Dial, by whom time may be most certainly measured, if there be good consideration of the variation of the Needle, by which the Equinoctial Dial is directed, for this is a general thing to be regarded, as well in the Compass, as in any Dials, or other Instrument, or conclusion whatsoever,

eber, wherein the vſe of the Needle is required, that vnleſs there be good regard vnto the variation of the ſame, there can no good Concluſion followe of any ſuch practiſes.



What

What is the next neceſſary thing to be learned?

HAving perfectly learned the Compaſs, the next neceſſary thing for a Seaman to know, is the alteration or ſhifting of Tydes, that thereby he may with the greater ſafety bring his Ship into any barred Port, Haven, Creek, or other place, where Tydes are to be regarded. And this difference of Tydes in the alteration of Flowing and reflowing, is by long experience found to be governed by the Moons motion, for in ſuch proportion of time as the Moon doth ſeparate her ſelf from the Sun, by the ſwiftneſs of her natural motion: in the like proportion of time doth one Tyde differ from another, therefore to underſtand this difference of the Moons motion, is the only mean whereby the time of Tyde is moſt preciſely known.

Of the Moons Motion.

YOu muſt underſtand the Moon hath two kinds of Motions: a natural motion, and a violent motion: her violent motion is from the Eaſt toward the Weſt, cauſed by the violent ſwiftneſs of the diurnal motion of Primum Mobile, in which motion the Moon is carried about the Earth in 24 hours and 50 minuts nereſt one day with another, for although the diurnal period of the firſt Mover be performed in 24 hours, yet becauſe the Moon every day in her ſloweſt natural motion moveth 12 degrees, therefore ſhe is not carried about the Earth, until that her motion be alſo carried about, which is in 24 hours and 50 minuts nereſt.

Her natural Motion is from the Weſt towards the Eaſt, contrary to the motion of the Firſt Mover, wherein the Moon hath three differences of moving, a ſwift motion, a mean motion, and a ſlow motion: all which is performed by the Divine Ordinance of the Creator in 27 dayes and 8 hours nereſt, through all the Deg. of the Zodiack.

Her ſlow Motion is in the point of Auge or Apogeo, being then fartheſt diſtant from the Earth, and then ſhe moveth in every day 12 degrees.

Her ſwift Motion is in the oppoſite of Auge or Perigeo, being nereſt unto the Earth, at which times ſhe moveth 14 degrees, with ſmall difference of minuts in every 24 hours.

Between thoſe two Points is her mean Motion, and then ſhe moveth 13 degrees nereſt: all which differences are cauſed by the excentricity of her Orbe wherein ſhe moveth, and are only performed in the Zodiack, but the Seamen for their better eaſe in knowledge of the Tydes, have applied this the Moons motion to the points, degrees, and minuts of the Compaſs, whereby they have framed it to be an Horizontal motion, which with long practiſe is found to be a rule of ſuch certainty, as that the error thereof bringeth no danger to the expert Seaman, therefore it is not amiſs to follow their practiſed precepts therein.

In

In every 29 dayes 12 hours 44 minuts, with another through the year, the Sun and Moon are in conjunction, and therefore that is the quantity of time betweén Change and Change, for although the Moon in 27 dayes and 8 hours, performing her natural motion, doth return to the same minute of the Zodiack from whence she departed, yet being so returned, she doth not find the Sun in that part of the Ecliptick where she left him, for the Sun in his natural motion moving every day one degrée towards the East, is movedso far from the place where the Moon left him, as that the Moon cannot overtake the Sun to come in Conjunction with him, until she have performed the motion of two dayes 4 hours, and 44 minuts néerest, more than her natural revolution, and that is the Cause wherefore there are 29 dayes 12 hours, 44 minuts betweén Change and Change one with another through the whole year: but the Seaman accompteth the Moons motion to be uniform in all places of the Zodiack alike, limiting her generall separation from the Sun to bée such as is her slowest natural motion, which is 12 degrées, or 48 minuts of time, in every 24 hours.

By which accompt there are 30 dayes reckoned betwéen Change and Change, being 11 hours, 16 minuts, more than in truth there is: but because this difference breedeth but small error in their accompt of Tydes, therefore to alter practised Rules where there is no urgent cause, were a matter frivolous, which considered I think it not amiss that we proceed therein by the same method that cómonly is exercised.

Allowing the Moon in every 24 hours, to depart from the Sun 12 degrées, or 48 minuts of time, and in this separation the Moon moveth from the Sun Eastward, until she be at the Full: for betwéen the Change and the Full, it is called the Moons separation from the Sun: for after the Full, she doth apply towards the Sun, so that betwéen the Full and the Change, it is called the Moons Application to the Sun, in which time of Application she is to the Westward of the Sun, as in her separation she is to the Eastward, or I may say in the Seamans phrase, all the time of her Application she is before the Sun, and in the time of her separation she is abaft the Sun.

Then if the Moon do move 48 minuts of time in 24 hours, it followeth that she doth move 24 minuts in 12 hours, and in 6 hours she moveth 12 minuts: therefore every hour she moveth 2 minuts, and such as is the difference of her motion such is the alteration of Tydes, and therefore every Tyde differeth from the other 12 minuts, because there is 6 hours betwéen Tyde and Tyde: and in every hour the course of flowing or reflowing altereth 2 minuts, whereby it appeareth that in 24 hours the four Tydes of Flowing and reflowing do differ 48 min. of time. And sith the whole knowledge of this difference or alteration of Tydes, as also the quantity of the Moons Separation and Application to, and from the Sun, dependeth upon the knowledge of the Moons age, it is therefore necessary, that next you learn how the Sun may be known.

For

For the performance whereof, there are two Numbers especially required named the Prime and the Epact, for by the Prime the Epact is found, and by help of the Epact the Moons age is known.

Of the Prime, or Golden Number.

The Prime is the space of 19 years, in which time the Moon performeth all the varieties of her motion with the Sun, at the end of 19 years beginneth the same Revolution again, therefore the Prime never exceedeth the number of 19, and this Prime doth alwayes begin in January, and thus the Prime is found: Unto the year of the Lord wherein you desire to know the Prime, adde 1, then divide that number by 19, and the remaining number which cometh not into the Quotient is the Prime.

Example: In the year of our Lord 1590, I desire to know the Prime, therefore I adde 1 unto that year, and then it is 1591, which I divide by 19, and it yieldeth in the Quotient 83, and there remaineth 14 upon the division, which cometh not into the Quotient, which 14 is the Prime in the year of our Lord, 1590.

	1
1590	4
1	774
1591	1591 (83
	152
	1

The Epact is a number proceeding from the over-plus of the Solar and Lunar year, which number never exceedeth 30, because the Moons age never exceedeth 30, for the finding whereof this number only serveth: and thus the Epact is known, which Epact doth alwayes begin in March, multiply the prime by 11 (being the nearest difference betwæn the Solar and Lunar year) divide the product by 30 and the remainder is the Epact. Example: In the year of our Lord 1590, I would know the Epact, first I seek the Prime of that year, and find it to be 14, I therefore multiply 14 by 11 and that yieldeth 154, which being divided by 30, it giveth the Quotient 5, and there remaineth 4 upon the division, which 4 is the Epact in the yeer 1594, which beginning in March, doth continue until the next March of the year 1591.

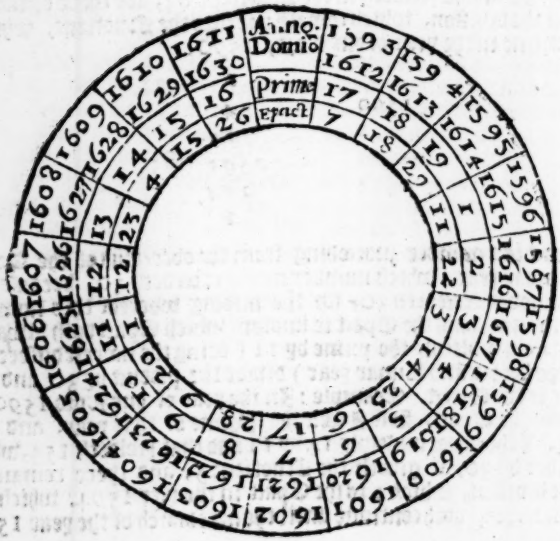
14	
11	30 (4 (5
14	
14	
154	

Of

Of the Solar and Lunar Year.

THe Solar year, or the Suns year, consisteth of 12 months, being 365 dayes, and about 6 hours, the Lunar year or the Moons year, containeth 12 Moons, and every Moon hath 29 dayes, 12 hours, 44 minuts neerest, which amount unto 354 dayes, 5 hours, 28 minuts. the content of the Lunar year, which being substracted from 365 days, 6 hours, there resteth 11 dayes and 23 minuts, the difference between the said years, from which difference the Epact cometh.

BY this Table the Prime and Epact may for ever be found, for when the years be expired, you may begin again and continue it for ever at your pleasure.



The first Circle containeth the Years of our Lord, the second the Prime, and the third and inner Circle sheweth the Epact: under every year you shall find his Prime and Epact, the Prime beginneth in January, and the Epact in March.

How

How to find out the Moons Age.

FIrſt, Conſider the day of the Month wherein you ſeek the Moons age, then note how many Months there are between the ſaid Month and March, including both Months, unto thoſe Numbers adde the Epact of that year, that is, you muſt adde into one ſum the day of the Month, between March and your Month, reckoning both Months and the Epact, all which numbers joyned together, if they exceed not 30 is the Moons age, if they be more than 30, caſt away 30 as often as you can, and the remainder is the Moons age, if it be juſt 30 it is then New Moon, if 7 it is the firſt Quarter day, if 15 it is Full Moon, if 22 it is then the laſt Quarter-day, and thus the Moons age is found for ever.

And now being able for all times either paſt, preſent, or to come, to give the Moons age, I think it good by a few Queſtions convenient for the Seamans practiſe, to make you underſtand the neceſſary uſe thereof.

For the account of Tydes.

WHen you deſire to know the time of Full Sea in any place at all ſuch ſeaſons as occaſion ſhall require, you muſt firſt learn what Moon maketh a Full Sea in the ſame place, that is, upon what point of the Compaſs the Moon is, when it is Full Sea at the ſaid place, you muſt alſo know what hour is appropriated to that point of the Compaſs as before is ſhewed: For upon the Change day it will always be Full Sea in that place, at the ſame inſtant of time, by which conſiderations you muſt thus proceed for the ſearch of Tydes.

Multiply the Moons age by 4, divide the product by 5, and to the Quotient adde the hour, which maketh Full Sea in that place upon the Change day: if it exceed 12, caſt away 12 as oft as you may, and then the hour of Full Sea remaineth: and for every 1 that reſteth upon your Diviſion, allow 12 minuts to be added to the hours, for 2, 24 minuts: for 3, 36: and for 4, 48 minuts: for more then 4 will never remain: and thus you may know your Tydes to a minute:

Example: The Moon being 12 dayes old, I deſire to know the time of Full Sea at London: Firſt it is found by experience, that a Southweſt and Northeaſt Moon makes Full Sea at London: next I conſider that 3 of the Clock is the hour appropriated to that point of the Compaſs, which number I keep in memory, then I multiply the Moons age, being 12, by 4, and that yieldeth 48, which being divided by 5, it giveth in the Quotient 9, and 3 remaineth: I adde the Quotient 9 to the hour 3 and it maketh 12 hours: and for the remaining number 3, I alſo adde 46 minuts, ſo that I find when the Moon is 12 dayes old, it is 12 of the Clock and 36 minuts paſt, at the inſtant of the Full Sea at London: By this order you may at all places & times know the certainty of your Tydes at your pleaſure.

But those that are not practised in Arithmetick, may account these Tydes in this sort, knowing how many dates old the Moon is, he must place the Moon upon that point of the Compass which maketh Full Sea at the place desired, & then reckoning from that point with the Sun according to the diurnal motion, must account so many points, and so many times 3 minuts as the Moon is dates old: that is, for every day one point and 3 minuts, and there finding the Sun, he must consider what is the hour allowed to that point where he findeth the Sun, for that is the hour of Full Sea.

As for Example: The Moon being 12 dates old, I desire to know the hour of Full Sea at London, now finding by former experience, that a Southwest Moon maketh Full Sea at London, I therefore place the Moon upon the point Southwest, then I account from the point Southwest 12 points, reckoning with the Sun according to the diurnal motion, Southwest and by West for the first point, West Southwest for the second, West by South for the third, West for the fourth point, and so forth, until I come to North, which is 12 points from the Southwest, and because the Moon moveth 3 minuts more than a point in every day, I therefore adde 3 times twelve which make 36 minuts to the point North, at which place I find the Sun to be, and knowing that 12 of the Clock is appropriated to the point North. I may therefore boldly say that at twelve of the Clock 36 minuts past, it is full Sea at London, when the Moon is 12 dayes old, which 36 minuts are added, because the Moon hath moved 36 minuts more than 12 points in those 12 dayes, which is one point and 3 minuts for every day, as before.

Here followeth a very necessary Instrument for the knowledge of the Tydes, named *An Horizontal Tyde-Table.*

Of this Instrument, and his Parts.

This necessary Instrument for the young practising Seamans use, named, An Horizontal-Tyde-Table, whereby he may shift his Sun and Moon (as they term it) and know the time of his Tydes with ease and very certainly. (besides the answering of many pleasant and necessary

necessary Questions used amongst Mariners) I have contrived into this method, only for the benefit of such young practisers in Navigation.

The first part of this Instrument is a Sea Compass, divided into 32 points, or equal parts: the innermost Circle of which Compass is divided into 24 hours, and every of those into 4 quarters, each quarter being 15 minuts, and against every point of the Compass those places are layd down, in which places it is full Sea when the Moon cometh upon the same point, so that whatsoever is required as touching time, or the points of the Compass is there to be known.

The next moveable circle upon this Compass, is limited to the Sun, upon whose Inder the Sun is laid down, which Circle is divided into 30 equal parts or dayes, signifying the 30 dayes between Change and Change, according to the Seamans account, so that whatsoever is demanded as touching the age of the Moon, is upon that Circle to be known.

The uppermost moveable Circle is applyed to the Moon upon whose Inder the Moon is laid down, which is to be placed either to the points and parts of the Compass, or to the time of her age, as the Question requireth: which considered, the use of this Instrument is largely manifested, by these Questions with their Answers following.

How to know the hour of the Night by the Moon, being upon any point of the Compass by this Instrument.

1. Q. The Moon 10 dayes old, I demand what is a Clock when she is East Northeast?

1. A. In this Question the Moons age and the point of the Compass is given, thereby to know the hour, I therefore place the Inder of the Moon upon the point East Northeast, there keeping the same not to be moved, then because the Moon is 10 dayes old, I move the Inder of the Sun until I bring the 10 day of the Moons age unto the Inder of the Moon, and there I look by the Inder of the Sun, and find upon the Compass that it is 12 of the Clock at noon and 30 minuts past, when the Moon is upon the point East Northeast, being 10 dayes old.

2. Q. The Moon being 12 dayes old, I demand at what hour she will be upon the point S.S.E?

2. A. In this Question the point of the Compass and Moons age is given as in the first, therefore I place the Inder of the Moon upon the point S.S.E. And there holding it without moving, I turn the Inder of the Sun, until the twelfth day of the Moons age come to the Inder of the Moon, and then the Inder of the Sun sheweth me upon the Horizon the hour 8, therefore I say that at 8 of the Clock at night, the Moon was then upon the point South Southeast.

And thus you may at all times know the hour of the night by the Moon, upon any point of the Compass, so that the Moons age be also had.

How by this Instruction, you may know at all times upon what point of the Compass the Moon is.

1. Q. When the Moon is 10 dayes old, upon what point of the Compass shall she be at 9 of the Clock in the morning?

1. A. In this Question the hour of the day and the Moons age is given, thereby to find upon what point of the Compass she is at the same time. I therefore place the Inder of the Sun upon the Compass, at the hour 9 of the Clock in the morning, being upon the point Southeast, then I turn the Inder of the Moon untill I bring it to the 10 day of her age, and then I see upon the Compass, that the Moon is North and by East, and 15 minuts to the Eastwards, of 9 of the Clock when she is 10 dayes old.

2. Q. When the Moon is 20 dayes old, upon what point of the Compass will she be at 2 of the Clock in the afternoon?

2. A. I place the Inder of the Sun upon the hour 2, noted in the Compass, there holding the same without moving, then I turn the Inder of the Moon, until I bring it unto the 20 day of her age, and there I see upon the Compass that she is Northeast and by North, and 15. minuts to the Northward, at 2 of the Clock in the afternoon, when she is 20 dayes old.

To find the Moons age by this Instrument.

1. Q. When the Moon is North at 7 of the Clock in the forenoon, how old is she?

1. A. In this Question the point of the Compass and the hour is given, for the finding of the Moons age: therefore I set the Inder of the Sun upon the hour 7 in the forenoon, there holding it without moving, then I bring the Inder of the Moon to the point North, and then upon the Circle containing the dayes of the Moons age, I see the Moon is 8 dayes, and about 18 hours old, when she is North at 7 of the Clock in the forenoon.

2. Q. When the Sun is East, and the Moon Southeast, how old is the Moon.

2. A. In this Question the points of the Compass are only given for the finding of the Moons age, therefore I set the Inder of the Sun upon the point East, there holding him steady, then I put the Inder of the Moon upon the point Southwest, and there I see that the Moon is 18 dayes and 18 hours old, when the Sun is East, and she Southwest.

After this order by the variety of these few Questions, you may frame unto your self many other pleasant and necessary Questions, which

which are very easily answered by this Instrument: and entring into the reasons of their Answers, you may very readily by a little practise, be able by memory to Answer all such Questions with ease.

How to know the time of your Tydes by this Instrument.

1. Q. When the Moon is 12 dayes old, I desire to know the time of full Sea at London.

1. A. To answer this Question, I first look through all the points of the Compass of my Instrument, until I find where London is written, for when the Moon cometh upon the point of the Compass, it will then be full Sea at London: Therefore I place the Inder of the Moon upon the same point, which I find to be Southwest or Northeast, there holding the Inder not to be moved. then I turn the Inder of the Sun until I bring the 12 day of the Moons age to the Inder of the Moon, and then the Inder of the Sun sheweth me that at 12 of the Clock 36 minuts past, it is full sea at London, the Moon being 12 dayes old.

2. Q. The Moon being 21 dayes old, at what time is it full Sea at Dartmouth.

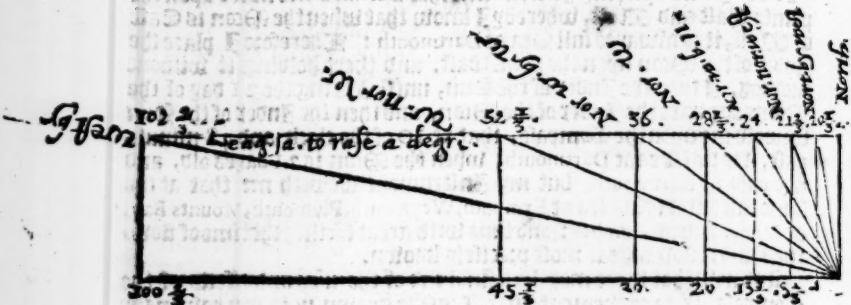
2. A. I find upon my Instrument that Dartmouth is noted upon the points East and West, whereby I know that when the Moon is East or West, it is allwayes full Sea at Dartmouth: Therefore I place the Inder of the Moon upon the point East, and there holding it without moving, I turn the Inder of the Sun, until I bring the 21 day of the Moons age unto the Inder of the Moon, and then the Inder of the Sun sheweth me upon the Compass, that at 10 of the clock and 48 minuts past, it is full Sea at Dartmouth, when the Moon is 21 dayes old, and not only at Dartmouth, but my Instrument sheweth me that at the same instant it is full sea at Exmouth, Weymouth, Plymouth, Mounts Bay, at Linne, and at Humber: and thus with great facility the time of flowings and reflowings is most precisely known.

And now that there may be a final end of the uses and effects of the Compass, it is convenient that I make known unto you how many leagues shall be sailed upon every particular point of the Compass, for the raising or laying of the degrees of latitude, and in the distance sailing how far you shall be separated from the meridian from whence the said courses are begun, for as every point of the Compass hath his certain limited distance for the degrees of the Pole elevation, so do they likewise lead from longitude to longitude, every point according to his ratable limits, which distances of leagues are without alteration, keeping one and the same proportion in every particular Horizon of any latitude, but the degrees of logitude answerable to such distances, do differ in every altitude, according to the nature of the parallel, as hereafter shall be more plainly manifested.

And now know that in sailing North and South, you depart not from your meridian, and in every 20 leagues sailing you raise a degree:

North

North and by East raiseth a degree in sailing 20 leagues and one mile, and leadeth from the meridian 4 leagues: North-north-east raiseth a degree in sailing 21 leagues and two miles, leadeth from the meridian 8 leagues and one mile: Nore-east by North, raiseth a degree in sailing 24 leagues, and leadeth from the meridian 13 leagues and a mile: North-east raiseth a degree in sayling 28 leagues and a mile, and leadeth from the meridian 20 leagues: North-east by East raiseth a degree in sailing 36 leagues, and leadeth from the meridian 30 leagues: East North-east raiseth a degree in sailing 52 leagues and a mile, and leadeth from the meridian 48 leagues and 2 miles: East and by North raiseth a degree in sailing 102 leagues and a mile, and leadeth from the meridian 100 leagues and 2 miles: East and West do not raise or lay the Pole, but keep still in the same Parallel: The like allowance is to be given to every quarter of the Compass, as is laid down upon this North-east quarter.



Leagues separated from the Meridian in raising a degree.

Q. I perceive that degrees are to great purpose in Navigation.

What is a degree?

Answ. IT is most true, that Degrees are of very great imployment in Navigation, and a Degree is the 360 part of a Circle, how big or little soever the Circle be, being applied after six several sorts, for the better perfections of the practises Gubernantick, so that there be degrees of Longitude, degrees of Latitude degrees of Azumuth, degrees of Altitude, degrees applied to Measure, and degrees applied to Time.

A Degree

A Degrée of Longitude is the 360 part of the Equinoctial.
A Degrée of Latitude is the 360 part of the Meridian.
A Degrée of Azumuth is the 360 part of the Compass, or Horizon.
A Degrée of Altitude is the 90 part of the Vertical Circle, or the 90 part of the distance between the Zenith and the Horizon.

Every Degrée applied to measure, doth contain 60 minuts, and every minute 60 seconds, and every second 60 thirds, &c. and every degrée of a great Circle so applied, containeth 20 leagues, which is 60 miles, so that every minute standeth for a Time in the accompt of measures, and a mile is limited to be 1000 paces, every pace 5 foot, every foot 10 inches, and every inch 3 barly corns dry and round, after our English accompt, which for the use of Navigation is the only best of all other: So by these rates of measure you may prove that a Degrée is 20 leagues, or 60 miles, a minute is a mile, or 5000 fæt, a second is 83 fæt, and 2 thirds; and a third is 16 inches and 2 thirds: and thus much of Degrees and their parts applied to measure.

Of Degrees applied to Time, there are 15 contained in every hour, so that every degrée of time standeth in the accompt of time for four minuts, for an hour consisteth of 60 minuts of time, hath for his fifteenth part 4 minutes, so that a degrée being the fifteenth part of an hour, containeth 4 minuts of time, so that 15 degrées, or 60 minuts make an hour, 24 hours make a natural day, and 365 dayes 6 hours are contained in a year: And thus much as touching Time, and Degrées applied to Time.

What is the use of Degrees?

THe use of Degrées is to measure distance between place and place, to find Altitudes, Latitudes, and Longitudes, to describe Countries, to distinguish Courses, to find the variation of the Compass, to measure time, to find the places and motions of all Celestial Bodies, as the Sun, Moon, Planets, and Stars: To conclude, by Degrees have been performed all Mathematical observations whatsoever, whose use is infinite.

What is the Poles Altitude, and how it may be known.

ALtitude is the distance, height, or mounting of one thing above another, so that the Altitude of the Pole, is the distance, height, or mounting of the Pole from the Horizon, and is defined to be that portion of the Meridian which is contained between the Pole and the Horizon, which Altitude or Elevation is to be found either by the Sun, or by the fixed Stars, with the help of your Cross-staff, Quadrant, or Astrolaby, but the Cross-staff is the only best Instrument for the Seamans use.

And in the observation of this Altitude there are five things especially

ly to be regarded: the first is, that you know your Meridional distance betwéen your Zenith and the Sun or Stars, which by your Crols-staff or Astrolaby is given: the second, that the declination be truly known at the time of your observation. And the other three are, that you consider whether your Zenith be betwéen the Equinoctial and the Sun or Stars, or whether the Equinoctial be betwéen your Zenith and them, or whether they be betwéen your Zenith and the Equator, for there is a several order of working upon each of these three differences.

Latitude you must also know, That so much as the Pole is above the Horizon, so much is the Zenith from the Equinoctial, and this distance betwéen the Zenith and the Equator is called Latitude or wideness, and is that portion of the meridian which is included betwéen your Zenith and the Equator: For it is a general Rule for ever, That so much as the Pole is above the Horizon, so much the Zenith is from the Equinoctial: so that in this sence, Altitude and Latitude is all one thing, the one having relation to that part of the meridian, contained betwéen the Pole and the Horizon, and the other to that part of the meridian which is contained betwéen the Zenith and the Equinoctial.

You must further understand, that betwéen the Zenith and Horizon, it is a quarter of a great Circle containing 90 Degrées so that knowing how much the Sun or any Star is from the Horizon, if you take that distance from 90, the remainder is the distance betwéen the said Body, and the Zenith.

As for Example: If the Sun be 40 degrées 37 minuts from the horizon, I substract 40 degrées 37 minuts from 90, and there remaineth 49 degrées 23 minuts, which is the distance betwéen my Zenith and the Sun, &c. Those Instruments that begin the accompt of their degrées at the Zenith, concluding 90 in the Horizon, are of most ease for the finding of the Latitude by the Sun or fixed Stars, because they give the distance betwéen the Zenith and the Body observed without further trouble, and that is the number which you must have, and for which you do search in your Observation: All which things considered, you must in this sort proceed for the finding of the Poles height or Altitude.

By the Sun, or fixed Stars, being between the Zenith and the Equinoctial, the Latitude is thus found, in what part of the world soever you be.

FIrst, Place the Crols-staff to your Eye, in such good sort as that there may grow no error by the disorderly using thereof, for unless the Center of your Staff, and the Center of your Sight do joyn together in your observation, it will be erroneous what you conclude thereby: Your Staff so ordered, then move the Transversary upon your Staff to and fro as occasion requireth, until at one and the same instant you

you may ſee by the upper edge of your Tranſverſary, halfe the body of the Sun or Starr, or that the lower edge or end thereof do likewiſe touch the Horizon, at that place where it ſeemeth that the skie and Seas are ioyned, having eſpecial regard in this your obſervation, as that you hold the Tranſverſary as directly upright as poſſibly you may, and you muſt begin this obſervation ſomewhat before the Sun or Starr be at South, and continue the ſame ſo long as you perceive that they riſe: for when they are at the higheſt, then are they upon the Meridian, and then you have the Meridional Altitude which you ſeek, at which time they will be due South from you, if your Compaſs be good and without variation, and then both the Tranſverſary ſhew upon the Staff the degrees and minuts that the ſaid body is from your Zenith, if the degrees of your Inſtrument be numbred from the Zenith toward the Horizon: or elſe it ſheweth the diſtance between the ſaid body and the Horizon, if the degrees of your Inſtrument be numbred from the Horizon, concluding 90 in the Zenith, as commonly Croſs-ſtaves are marked, which is not the eaſieſt way: but if your ſtaff be accompted from the Horizon, then ſubſtract the degrees of your obſervation from 90. and the remainder ſheweth the diſtance between your Zenith and the Sun or Starr, which is the number you muſt know: unto that number ſo known by your Inſtrument, adde the declination of the body by which you do obſerve, whether it be the Sun or ante Starr, and that which cometh by the addition of thoſe two numbers together, is the Poles height, or the latitude of the place where you are: as for Example, In the year of our Lord 1621, the third day of March, the Sun being then between my Zenith and the Equinoctial, I obſerved the Suns Meridional altitude from the Horizon to be 72 degrees and 20 minuts, but becauſe I muſt know the diſtance of the Sun from my Zenith, I therefore ſubſtract 72 degrees 20 minuts from 90 degrees, and there remaineth 17 degrees 40 minuts, the diſtance of the Sun from my Zenith, to that diſtance I adde the Suns declination for that day, which by my Regiment I find to be 43 minuts 2 degrees of South declination, and it amounteth unto 20 degrees 23 minuts, ſo much is the ſouth Pole above the Horizon, and ſo much is my Zenith South from the Equinoctial, becauſe the Sun having South declination, and being between me and the Equinoctial, therefore of neceſſity the Antartick Pole muſt be above my Horizon.

89—60—the diſtance between the Zenith and the Horizon.
72—20—the Suns Altitude.
17—40—the Suns degree from the Zenith.
2—43—the Suns Declination.

20—23—the Poles height.

When the Equinoctial is between your Zenith and the Sun or Stars, the Altitude is thus found in all places.

BY your Instrument, as before is taught, you must take the Meridional distance of the Sun or Stars from your Zenith: which being known, subtract the Declination of the Sun or Stars from the said distance, & the remaining number is the Poles height, or latitude which you seek: Example.

The 20 of October 1625. I find by my Instrument that the Sun is 60 deg. 45 minuts from my Zenith at Noon, being then upon the Meridian, the Equator being then between my Zenith and the Sun: I also find by my Regiment that at that time the Sun had 13 deg. 57 min. of South Declination, because the Equinoctial is between me and the Sun, therefore I subtract the Suns declination from the observed distance, and there resteth 46 deg. 48 min. the latitude desired: and because the Sun hath the South declination, and the Equinoctial being between me and the Sun, therefore I may conclude that the Pole Artick is 46 deg. 48 min. above my Horizon, or that my Zenith is so much toward the South from the Equator.

g	m	
60	45	the Suns distance.
13	57	the Declination.
46	48	the latitude.

When your Zenith is between the Sun or Stars and the Equinoctial, the Latitude is thus found.

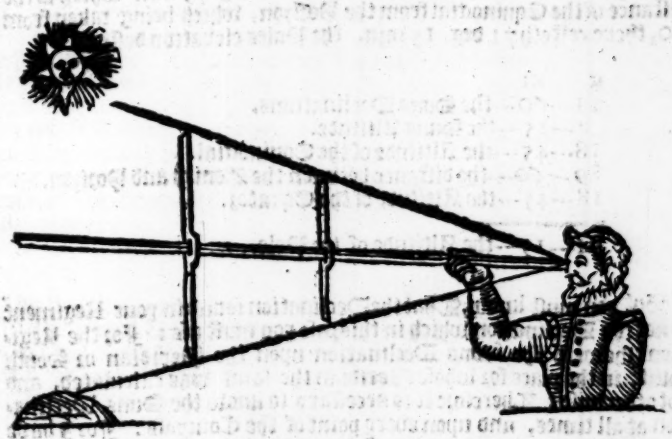
BY your Instrument, as in the first example is shewed, you must observe the Meridional distance, of the Sun or Stars from your Zenith: You must also by your Regiment or other Tables search to know the Declination of that body which you observe, then subtract the observed distance from your Zenith out of the Declination, and the remaining number is the Latitude desired: Example. The Sun having 20 deg. of South declination, and being upon the Meridian is 5 deg. 9 min. from my Zenith, I therefore subtract 5 deg. 9 min. from 20 deg. and there resteth 14 deg. 51 min. the Latitude desired: and because the Sun hath South Declination, my Zenith being between the Sun and the Equinoctial, therefore I conclude, That the South Pole is 14 deg. 51 min. above my Horizon.

g	m	
19	60	the Declination.
5	9	the Suns distance from my Zenith.
14	51	the Poles height.

Now

How shall I know the true order of placing the Cross-staff to mine eye, to avoid error in my Observation?

TO find the true placing of the staff at your Eye, thereby to amend the Parallax, or false shadow of your sight, do thus: Take a staff having two crosses, a long Crosse which endeth in 30 degrees, and a short Crosse which beginneth at 30 degrees where the long Cross endeth, put the long Cross upon his 30 degrees, and there make him fast: then put the short Cross likewise upon his 30 degrees, there fasten him without moving: then set the end of your staff to your Eye, moving it from place to place about your Eye, until at one instant you may see the ends of both Crosses, which when you find, remember that place and the standing of your body, for so must your staff be placed, and your Body ordered in all your Observations.



Are these all the Rules that appertain to the finding of the Poles height?

Those that Travel far towards the North, under whose Horizon the Sun setteth not, shall sometime have occasion to seek the Latitude by the Sun, when the Sun is North from them, the Pole being then betwéen the Sun and their Zenith. When such observations are made, you must by your Instrument séek the Suns height from the Horizon, substract that height from his Declination, and the remaining number sheweth how far the Equinoctial is under the Horizon upon the point North. for so much is the opposite part of the Equator above the Horizon upon the point South. substract that Meridian Latitude of the Equinoctial from 90, and the remaining number is the Poles height desired: Example.

The Sun having 22 degrées of North declination, his Altitude from the Horizon is observed to be 3 deg. 15 min. therefore substracting 3 deg. 15 min. from 22 degrées, there rest 18 deg. 45 min. which is the distance of the Equinoctial from the Horizon, which being taken from 90, there resteth 71 deg. 15 min. the Poles elevation desired.

g	m	
21	60	the Suns Declinations.
3	15	the Suns Altitude.
18	45	the Altitude of the Equinoctial.
89	60	the distance betwéen the Zenith and Horizon.
18	45	the Altitude of the Equator.
71	15	the Altitude of the Pole.

But you must know, That the Declination found in your Regiment is not the Declination which in this case you must use: For the Regiment sheweth the Suns Declination upon the Meridian or South point, in the place for whose Meridian the same was calculated, and not otherwise: Therefore it is necessary to know the Suns Declination at all times, and upon every point of the Compass: For I have béen constrained in my Norwest Voyages, being within the Frozen Zone, to search the Latitude by the Sun, at such time as I could sée the Sun, upon what point of the Compass soever, by reason of the Foggs and Mists that those Northern parts are subject unto: And there is consideration also to be had upon every difference of Longitude for the Suns Declination, as I have by my experience found at my being in the Straits of Magilane, where I have found the Suns Declination to differ from my Regiment calculated for London, by so much as the

the Sun declineth in 5 hours, for so much is the difference between the Meridian of London, and the Meridian of Cape Froward, being in the midst of the said Straits.

How may this Declination be found for all times, and upon all points of the Compass.

First, Consider whether the Sun be coming towards the Equinoctial, or going from him: That being known, consider the time wherein you seek the Declination, then look for the Suns Declination in your Regiment for that day, and also seek his Declination for the next day, substract the lesser out of the greater, and the remainer is the whole Declination which the Sun declineth in 24 hours, or in his mooving through all the points of the Compass, from which number you may by the Rule of Proportion find his Declination upon every point of the Compass for every hour of the day, as by these Examples may appear:

Example.

In the Year 1625, the 20 of March, I desire to know the Suns Declination when he is upon the North part of the Meridian of London, I seek the Suns Declination for that day, and find it to be 3 deg. 59 min. the Sun then going from the Equator. I also search his Declination for the next day, being the 21 day of March, and find it to be 4 deg. 22 min. I then substract 3 degrees 59 minutes from 4 degrees 12 minutes, and there resteth 23 min. [illegible] the Sun doth decline in 24 hours, or in going through all the points of the Compass. Then I say by the rule of Proportion, If 24 hours give 23 minutes of Declination, what will 12 hours give, &c. I Multiply and Divide, and find it to be 11 min. 30 sec. the Suns Declination in 12 hours motion to be added to the Declination of the 20 day, being the Sun going from the Equator: Or for the points of the Compass, I may say, If 32 points give 22 min. of Declination, what will 16 points give,

which

which is the distance between South and North: I Multiply and Divide, as the rule of Proportion requireth, and find that 16 points give 11 min. the Suns Declination, in moving through 16 points of the Compass, which is to be added to the Declination of the 20 day, because the Sun goeth from the Equator, so I conclude the Declination to be 3 deg. 52 min. the Sun being North the 20 of March.

In this work the 30 seconds are omitted.

ho.	mo.	ho.	
24	23	12	11
	12		
	44	2	
	22	264	(11
		244	
	264	2	

po.	m.	po.	m.
32	22	16	11
	16		
		3	
	192	352	(11
	22	322	
		3	
	352		

Being West from the Meridian of London 90 degrees of Longitude, I desire to know the Suns Declination when the Sun is upon the Meridian the 20 of March 1625. I must here consider that 90 deg. of Longitude make 6 hours of Time, for every hour containeth 15 deg. whereby I know that when the Sun is South at London, he is but West from me: for when it is 12 of the Clock at London, it is but 6 of the Clock in the morning with me: & when it is 12 of the Clock with me, it is three of the Clock in the afternoon at London: therefore I must seek for the Declination of the Sun at 6 of the Clock in the afternoon, and that is the Meridional Declination which I must use, being 90 deg. West from London, which to do, the last Example [illegible] easily gather the perfect notice

notice of whatsoever is requisite in any of these kind of Observations, if you read with the eye of Reason, and labour to understand with judgement that which you read.

Example.

The day and year proposed being the 20 of March 1625: Declination the 3 deg. 59 min. the next day 21 of March 4 deg. 22 min. Deduction made, resteth 23 min. the proportional part to be found for 90 deg. West, or 6 hours of Time. Now, if 24 hours give 23, What 6 hours? Facit 5 min. 18 seconds, which being that the Declination encreaseth, adde 5 min. 18 seconds to the Declination for the day prefixed: that total is the Meridional Declination for 90 degrees of Westerly Longitude from the Meridian of London.

There is another way most excellent for the finding of the Suns Declination at all times, that is to search by the Ephemerides the Suns true place in the Ecliptick for any time proposed whatsoever, and then by the Tables of Sinus the Declination is thus known: Multiply the Sinus of the Suns Longitude from the Equinoctial points of Aries or Libra, to which soever he is neerest, by the Sinus of the Suns greatest Declination, and divide the Product by the whole Sinus, and the Ark of the Quotient is the Declination desired: but because Seamen are not acquainted with such Calculations, I therefore omit to speak further thereof, sith this plain way before taught is sufficient for their purpose.

The Use of this Instrument.

By this Instrument you may sufficiently understand the Reasons of whatsoever is before spoken for the finding of the Poles Elevation, or the Latitude of your being: Into the consideration whereof, because the young Practiser may the better enter, I think it not amiss by a few Examples to express the necessary use thereof.

1. Q. The Sun being 7 deg. of North Declination, and the Pole Artick being 45 deg. above the Horizon, I demand what will be the Suns Meridional distance from my Zenith?

1. A. First I turn the Horizon until I bring the North Pole to be 45 deg. above the same, there holding the Horizon not to be moved, I then bring the thrill that is fastned to the Center of the Instrument, 7 degrees from the Equinoctial towards the North, because the Sun hath

hath so much North Declination, and the thrid doth shew me upon the vertical Circle, that the Sun is 38 deg. from the Zenith.

2. Q. The Pole Artick being 50 deg. above the Horizon, and the Suns distance 30 deg. from the Zenith, I demand what is the Suns Declination?

2. A. As in the first Question I place the North Pole 5 deg. above the Horizon, there holding the Horizon not to be moved, then I bring the thrid to the 30 deg. upon the vertical Circle, because the Sun is 30 deg. from my Zenith, and then the thrid sheweth upon the Meridian betwéen the Tropick of Cancer and the Equinoctial, that the Sun hath 20 degrées of North Declination.

3. Q. The Sun having 10 deg. of South Declination, being upon the Meridian, is 53 deg. from my Zenith, I demand what is the Poles height?

3. A. In

A. 3. In the firſt queſtion the Poles height and the Suns declination are given for the finding the Suns meridional diſtance from the Zenith. In the ſecond the Poles height is given, and the Suns meridionall diſtance from the Zenith, thereby to find the Suns declination. And in this queſtion the Suns declination and meridionall diſtance, is given for the finding of the Poles height. I therefore bring the third faſtned in the Center of the Inſtrument 10 degrees South from the Equator, betweene the Equinoctiall and the Tropicke of Capricorne, there holding the third not to be moved, I then turne to the Horizon, untill I bring the 53 degree of the verticall circle under the third, and then the Horizon ſheweth me, that the North Pole is 43 degrees above the ſame.

Q. 4. The Sun having 12. degrees of South declination, and being upon the Meridian South from me, is 30. degrees above the Horizon, I demand how far the Sun is from my Zenith, how much the Equinoctiall is above the Horizon, and what is the Poles height?

A. 4. Firſt, I bring the third to the place of the Suns declination, as before, there holding it not to be moved, then I turne the Horizon untill I bring it to be 30. deg. under the third, and then the third ſheweth me, that the Sun is 60. deg. from my Zenith, and the Horizon ſheweth that the Equinoctiall is 42. deg. above the ſame, and that the North Pole is alſo elevated 48. deg. above the Horizon; although theſe queſtions are ſo very eaſie and plain, as that they may readily be anſwered by memory, yet becauſe the reaſons how they are anſwered may the better appeare, is the cauſe wherefore they are demanded, and in this ſort anſwered, only for the benefit of ſuch as are not altogether expert in theſe practiſes, that thereby they might likewiſe frame unto themſelves queſtions of other variety, and ſo, gather thereby the more ſufficient iudgement in this part of Navigation.

What is the Zenith?

THe Zenith is that prick, or point, in the heavens, which is directly over your head, from whence a line falling perpendicularly, will touch the place of your being, and ſo paſſe by the Center of the ſphere. and this line may be called the Axis of the Horizon, and the Zenith the Pole of the ſame, being 90. d. from all parts thereof, as by the former figure may moſt plainly appear.

The use of the Tables of the Sunnes declination.

BEcause the height of the pole (which is equall to the latitude of any place) cannot be exactly known, except you have the Suns true declination; here are Tables of the Suns declination, exactly calculated for the yeares, 1649. 1650. 1651. 1652. which will serve untill the year 1672. without correction, because there will be no sensible error in their use. And these are the plainest of any Tables of the Suns declination, that are extant; the declination is nominated, whether it be North, or South. Between the Columns and the Equinoctiall, is signified by three black lines in *March*, when the declination comes to be North; and it is signified by one black line in *September*, when the declination comes to be South; and there are the yeares in every month, for which the declination serveth at the top of the Tables. But besides the Tables of declination, the whole book hath not any equall to it, of its quantity, for the direction of young beginners; there being in it the principles of the Sphere, and the ground and foundation of Navigation, with divers other things, that are very usefull, commodious, and pleasant. But for a further description of the Tables, you have in every month four great columnes, each of them consisting of three lesser columnes; in the first column is the dayes of the month, in the second is the degrees of the Suns declination, under the letter G, and in the third is the minutes, under the letter M. The first of the great columnes serving for the first year after leap year; the second for the second year; the third for the third year; and the fourth for the leap years, *viz.* 1652. 1656. 1660. 1664. 1668. 1672.

To finde the Suns declination at any time, first seeke the month, then the yeare of our Lord, and the day of the month, and right against the day of the month, under the yeare of our Lord, is the Suns declination. Example. The 10th day of *March*, 1651. I desire to know the Suns declination, in *March* I look for it, 1651. and find it over the third great column, and right against the 10th. day I finde 00 degrees and 02 minutes South declination, and the like is to be done for any other.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M	D.	G.	M	D.	G.	M	D.	G.	M
1	21	43	1	21	47	1	21	49	1	21	51
2	21	34	2	21	37	2	21	39	2	21	41
3	21	25	3	21	27	3	21	29	3	21	31
4	21	12	4	21	16	4	21	19	4	21	20
5	21	01	5	21	05	5	21	07	5	21	09
6	20	50	6	20	53	6	20	56	6	20	58
7	20	38	7	20	41	7	20	44	7	20	46
8	20	25	8	20	29	8	20	32	8	20	34
9	20	22	9	20	16	9	20	20	9	20	22
10	20	00	10	20	03	10	20	07	10	20	09
11	19	46	11	19	49	11	19	53	11	19	56
12	19	32	12	19	35	12	19	39	12	19	42
13	19	17	13	19	21	13	19	25	13	19	28
14	19	03	14	19	06	14	19	10	14	19	13
15	18	48	15	18	52	15	18	55	15	18	58
16	18	33	16	18	36	16	18	40	16	18	43
17	18	17	17	18	21	17	18	24	17	18	28
18	18	01	18	18	05	18	18	09	18	18	12
19	17	45	19	17	49	19	17	52	19	17	56
20	17	28	20	17	32	20	17	36	20	17	40
21	17	11	21	17	15	21	17	20	21	17	23
22	16	54	22	16	58	22	17	02	22	17	07
23	16	36	23	16	41	23	16	45	23	16	50
24	16	18	24	16	23	24	16	27	24	16	33
25	16	00	25	16	05	25	16	09	25	16	15
26	15	42	26	15	46	26	15	51	26	15	56
27	15	23	27	15	28	27	15	32	27	15	38
28	15	04	28	15	09	28	15	13	28	15	20
29	14	45	29	14	50	29	14	54	29	15	01
30	14	26	30	14	31	30	14	35	30	14	42
31	14	06	31	14	11	31	14	16	31	14	22

South Declination. South Declination. South Declination. South Declination.

First.			Second.			Third.			Fourth.		
1642			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M.	D.	G.	M	D.	G.	M	D.	G.	M
1	13	46	1	13	51	1	13	56	1	14	01
2	13	26	2	13	31	2	13	36	2	13	41
3	13	05	3	13	11	3	13	16	3	13	21
4	12	45	4	12	51	4	12	56	4	13	01
5	12	24	5	12	31	5	12	35	5	12	40
6	12	03	6	12	09	6	12	14	6	12	19
7	11	42	7	11	48	7	11	53	7	11	58
8	11	21	8	11	27	8	11	32	8	11	37
9	10	59	9	11	05	9	11	11	9	11	16
10	10	38	10	10	44	10	10	49	10	10	54
11	10	16	11	10	22	11	10	27	11	10	33
12	09	54	12	10	00	12	10	06	12	10	11
13	09	33	13	09	38	13	09	44	13	09	49
14	09	10	14	09	16	14	09	21	14	09	27
15	08	47	15	08	54	15	08	59	15	09	04
16	08	25	16	08	31	16	08	36	16	08	42
17	08	02	17	08	08	17	08	14	17	08	19
18	07	39	18	07	46	18	07	51	18	07	57
19	07	16	19	07	22	19	07	29	19	07	34
20	06	53	20	06	59	20	07	06	20	07	11
21	05	30	21	06	36	21	06	42	21	06	48
22	06	07	22	06	13	22	06	20	22	06	25
23	05	44	23	05	50	23	05	56	23	06	02
24	05	21	24	05	26	24	05	33	24	05	39
25	04	57	25	05	03	25	05	10	25	05	15
26	04	34	26	04	40	26	04	46	26	04	52
27	04	10	27	04	16	27	04	22	27	04	29
28	03	47	28	03	53	28	03	59	28	04	05
									29	03	41

South Declination. South Declination. South Declination. South Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M	D.	G.	M	D.	G.	M	D.	G.	M
1	03	23	1	03	29	1	03	35	1	03	17
2	03	00	2	03	06	2	03	11	2	02	53
3	02	36	3	02	42	3	02	47	3	02	30
4	02	13	4	02	18	4	02	24	4	02	06
5	01	49	5	01	55	5	02	01	5	01	43
6	01	25	6	01	31	6	01	37	6	01	19
7	01	01	7	01	07	7	01	13	7	00	55
8	00	38	8	00	43	8	00	49	8	00	31
9	00	14	9	00	20	9	00	25	9	00	07
10	00	10	10	00	04	10	00	02	10	00	16
11	00	33	11	00	38	11	00	22	11	00	39
12	00	57	12	00	51	12	00	46	12	01	03
13	01	21	13	01	15	13	01	09	13	01	27
14	01	44	14	01	39	14	01	33	14	01	51
15	02	08	15	02	02	15	01	56	15	02	14
16	02	31	16	02	26	16	02	20	16	02	38
17	02	55	17	02	49	17	02	44	17	03	02
18	03	18	18	03	12	18	03	07	18	03	25
19	03	42	19	03	36	19	03	30	19	03	48
20	04	05	20	03	58	20	03	52	20	04	11
21	04	28	21	04	21	21	04	16	21	04	34
22	04	51	22	04	44	22	04	40	22	34	57
23	05	14	23	05	08	23	05	03	23	05	20
24	05	37	24	05	31	24	05	26	24	05	43
25	06	00	25	05	55	25	05	49	25	06	06
26	06	23	26	06	17	26	06	12	26	06	29
27	06	45	27	06	40	27	06	34	27	06	52
28	07	07	28	07	02	28	06	57	28	07	14
29	07	30	29	07	25	29	07	20	29	07	36
30	07	52	30	07	47	30	07	42	30	07	59
31	08	15	31	08	09	31	08	04	31	08	21

South Declination. North Declination.

South Declination. North Declination.

South Declination. North Declination.

South Declination. North Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M.	D.	G.	M	D.	G.	M	D.	G.	M
1	08	36	1	08	30	1	08	26	1	08	42
2	08	57	2	08	52	2	08	48	2	09	04
3	09	19	3	09	14	3	09	10	3	09	25
4	09	41	4	09	35	4	09	31	4	09	48
5	10	02	5	09	57	5	09	53	5	10	08
6	10	23	6	10	18	6	10	14	6	10	29
7	10	45	7	10	40	7	10	35	7	10	50
8	11	05	8	11	00	8	10	56	8	11	11
9	11	26	9	11	21	9	11	17	9	11	33
10	11	47	10	11	42	10	11	38	10	11	53
11	12	07	11	12	02	11	11	57	11	12	13
12	12	28	12	12	22	12	12	17	12	12	33
13	12	47	13	12	42	13	12	37	13	12	53
14	13	07	14	13	02	14	12	57	14	13	13
15	13	26	15	13	22	15	13	17	15	13	33
16	13	46	16	13	41	16	13	36	16	13	52
17	14	05	17	14	00	17	13	56	17	14	11
18	14	24	18	14	19	18	14	14	18	14	30
19	14	42	19	14	38	19	14	33	19	14	48
20	15	01	20	14	56	20	14	52	20	15	06
21	15	19	21	15	14	21	15	10	21	15	24
22	15	37	22	15	32	22	15	28	22	15	43
23	15	54	23	15	50	23	15	46	23	15	56
24	16	12	24	16	07	24	16	03	24	16	19
25	16	29	25	16	24	25	16	20	25	16	33
26	16	45	26	16	41	26	16	37	26	16	51
27	17	02	27	16	58	27	16	54	27	17	07
28	17	18	28	17	14	28	17	11	28	17	23
29	17	34	29	17	31	29	17	27	29	17	39
30	17	50	30	17	46	30	17	42	30	17	54

North Declination. North Declination. North Declination. North Declination.

First.		Second.		Third.		Fourth.	
1649		1650		1651		1652	
1653		1654		1655		1656	
1657		1658		1659		1660	
1661		1662		1663		1664	
1665		1666		1667		1668	
1669		1670		1671		1672	
D.	G. M	D.	G. M	D.	G. M	D.	G. M
1	18 07	1	18 01	1	17 58	1	18 10
2	18 20	2	18 16	2	18 13	2	18 25
3	18 35	3	18 31	3	18 28	3	18 39
4	18 50	4	18 45	4	18 43	4	18 54
5	19 04	5	19 00	5	18 57	5	19 08
6	19 18	6	19 14	6	19 11	6	19 21
7	19 32	7	19 27	7	19 25	7	19 35
8	19 45	8	19 40	8	19 38	8	19 48
9	19 58	9	19 53	9	19 51	9	20 01
10	20 10	10	20 06	10	20 04	10	20 13
11	20 21	11	20 18	11	20 16	11	20 25
12	20 33	12	20 30	12	20 28	12	20 37
13	20 45	13	20 42	13	20 40	13	20 48
14	20 56	14	20 53	14	20 51	14	20 59
15	21 06	15	21 04	15	21 02	15	21 09
16	21 17	16	21 15	16	21 12	16	21 20
17	21 27	17	21 25	17	21 22	17	21 30
18	21 37	18	21 34	18	21 32	18	21 40
19	21 46	19	21 44	19	21 42	19	21 49
20	21 55	20	21 53	20	21 51	20	21 57
21	22 04	21	22 02	21	21 59	21	22 06
22	22 12	22	22 10	22	22 08	22	22 14
23	22 20	23	22 18	23	22 16	23	22 22
24	22 27	24	22 25	24	22 24	24	22 29
25	22 34	25	22 33	25	22 31	25	22 36
26	22 41	26	22 39	26	22 38	26	22 43
27	22 47	27	22 46	27	22 45	27	22 49
28	22 53	28	22 52	28	22 51	28	22 55
29	22 58	29	22 57	29	22 56	29	23 00
30	23 04	30	23 02	30	23 01	30	23 05
31	23 08	31	23 07	31	23 06	31	23 09

North Declination.

North Declination.

North Declination.

North Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M	D.	G.	M	D.	G.	M	D.	G.	M
1	23	12	1	23	11	1	23	10	1	23	13
2	23	16	2	23	15	2	23	14	2	23	16
3	23	20	3	23	19	3	23	18	3	23	20
4	23	23	4	23	22	4	23	21	4	23	23
5	23	25	5	23	25	5	23	24	5	23	25
6	23	28	6	23	27	6	23	26	6	23	27
7	23	30	7	23	29	7	23	28	7	23	29
8	23	31	8	23	30	8	23	29	8	23	30
9	23	31½	9	23	31	9	23	30	9	23	31
10	23	31½	10	23	31½	10	23	31	10	23	31½
11	23	31	11	23	31½	11	23	31½	11	23	31½
12	23	31	12	23	31	12	23	31½	12	23	31
13	23	30	13	23	30	13	23	31	13	23	30
14	23	29	14	23	29	14	23	30	14	23	29
15	23	28	15	23	28	15	23	29	15	23	28
16	23	26	16	23	26	16	23	27	16	23	26
17	23	24	17	23	23	17	23	25	17	23	23
18	23	21	18	23	21	18	23	22	18	23	20
19	23	18	19	23	18	19	23	19	19	23	17
20	23	14	20	23	14	20	23	16	20	23	13
21	23	10	21	23	10	21	23	13	21	23	09
22	23	05	22	23	06	22	23	09	22	23	04
23	23	01	23	23	02	23	23	04	23	22	59
24	22	55	24	22	57	24	22	58	24	22	54
25	22	50	25	22	53	25	22	52	25	22	48
26	22	44	26	22	45	26	22	47	26	22	42
27	22	37	27	22	38	27	22	40	27	22	36
28	22	30	28	22	31	28	22	34	28	22	29
29	22	23	29	22	25	29	22	27	29	22	22
30	22	16	30	22	18	30	22	20	30	22	14

North Declination.

What is the Charte?

THe Sea Chart is a speciall instrument for the Seamans use whereby the Hydrographicall description of the Ocean Seas, with the answering Geographicall limits of the earth, are supposed to be in such sort, given, as that the longitudes and latitudes of all places, with the true distance and course betwéene place and place, might be truly knowne. But because there is no proportionable agréement betwéen a Globus superficies, and a plaine superficies, therefore a Chart doth not expresse that certainty of the premises which is thereby pretended to be given, for things are best described upon bodies agreeable to their owne forme. And whereas in the true nature of the Sphere, there can be no Parallels described but the East and West courses onely, the rest of the courses being concurred lines, ascendent toward the Poles, the Meridians all concurring and joyning together in the Poles, notwithstanding in the Sea Chart all those courses are described as Parallels, without any diversity, alteration, or distinction to the contrary, whereby the instrument is apparantly faulty: yet it cannot be denied, but Charts for short courses are to very good purpose for the Pilots use, and in long courses, be the distance never so farre, if the Pilot returne by the same course, whereby in the first he prosecuted his voyage, his Chart will be without errour, as an Instrument of very great commodity, but if he returne by any other way, then by that which he went forth, the imperfections of the Chart will then appeare to be very great; especially, if the voyage be long, or that the same be in the North parts of the world, the farther towards the North, the more imperfect: therefore there is no Instrument answerable to the Globe, or paradoxall Chart, for all courses and climates whatsoever, by whom all declared truth is most plentifully manifested, as shall hereafter at large be declared, but for the coasting of any shore, or Countrey, or for short Voyages, there is no Instrument more convenient for the Seamans use, then the well described Sea Chart.

What is the use of the Sea Chart.

BY the directions of the Sea Chart the skilfull Pilot conveyeth his Ship from place to place, by such courses as by the Chart are made knowne unto him, together with the helpe of his Compasse, or Crosse staffe, as before is shewed, for the Crosse-staffe, the Compasse and the Chart, are so necessarily joynd together, as that the one may not well be without the other, in the execution of the practises of Navigation: for as the Chart sheweth the courses, so doth the Compasse direct the same, and the Crosse-staffe by every particular observed latitude doth confirme the truth of such courses, and also give the certaine distance that the Ship hath sayled upon the same.

And in the vse, or understanding of the Sea Chart, there are five things chiefly to be regarded.

The first is, that the Countries, or Geography of the Chart be known, with every Cape, Promontorie, Port, Haven, Bay, Sands, Rokes, and dangers therein contained.

Secondly, that the lines drawn upon the Chart, with their severall properties be likewise understood.

Thirdly, that the latitudes of such places as are within the Chart; be also knowne, as by the Chart they are expressed.

Fourthly, that you be able to measure the distances between place and place upon the Chart.

And fiftly, the Seaman must be able by his Chart, to know the true courses betweene any Iles, Continents, or Capes whatsoever: for by these five diversities, the Chart is to be used in the skil of Navigation.

How is the latitude of places knowne by the Chart.

THe latitude is thus found by the Chart, upon the place, whose latitude you desire to know, set one foot of your Compasses, then stretch the other foot to the nert East and West line (for that line is your Director) keeping that foot still upon the same line, move your hand and Compasses East, or West, as occasion requireth, untill you bring the Compasses to the graduated Meridian, and there that foot of the Compasses which stood upon the place, whose latitude you would know, doth shew the latitude of the same place.

How is the course between place and place knowne?

WHen there are two places assigned, the course between which you desire to know, set one foot of your Compasses upon one of the places, then by discretion consider the lines that lead toward the other place, stretching the other foot of the Compasses to one of those lines, and to that part of the line which is nearest to you, keeping that foot still upon the same line, move your hand and Compasses toward the other place, and see whether the other foot of the Compasses that stood upon the other place, doe by this direction touch the second place, which if it doe, then that line whereupon you kept the one foot of your Compasses, is the course between those places: but if it touch not the place, you must by discretion search untill you finde a line, whereupon keeping the one foot of the Compasses, will lead the other foot directly from the one place to the other, for that is the course between those two places.

How is the distance of places found upon the Chart?

IF the places be not farre asunder, stretch a paire of Compasses betweene them, setting the one foot of the Compasses upon one of the places, and the other upon the other place, then not altering the Compasses,

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M.	D.	G.	M.	D.	G.	M.	D.	G.	M.
1	17	40	1	17	36	1	17	32	1	17	44
2	17	56	2	17	52	2	17	48	2	18	00
3	18	12	3	18	08	3	18	04	3	18	16
4	18	28	4	18	24	4	18	20	4	18	32
5	18	43	5	18	40	5	18	36	5	18	47
6	18	59	6	18	55	6	18	51	6	19	02
7	19	13	7	19	10	7	19	06	7	19	17
8	19	28	8	19	24	8	19	21	8	19	31
9	19	42	9	19	38	9	19	35	9	19	45
10	19	55	10	19	52	10	19	49	10	19	59
11	20	09	11	20	05	11	20	03	11	20	12
12	20	22	12	20	17	12	20	17	12	20	25
13	20	34	13	20	30	13	20	28	13	20	38
14	20	46	14	20	43	14	20	41	14	20	50
15	20	58	15	20	54	15	20	53	15	21	01
16	21	10	16	21	06	16	21	04	16	21	12
17	21	21	17	21	17	17	21	15	17	21	23
18	21	31	18	21	28	18	21	26	18	21	33
19	21	41	19	21	38	19	21	37	19	21	43
20	21	51	20	21	48	20	21	47	20	21	53
21	22	00	21	21	57	21	21	55	21	22	01
22	22	09	22	22	06	22	22	04	22	22	11
23	22	17	23	22	15	23	22	13	23	22	19
24	22	25	24	22	23	24	22	21	24	22	27
25	22	33	25	22	31	25	22	29	25	22	35
26	22	40	26	22	38	26	22	36	26	22	42
27	22	47	27	22	45	27	22	42	27	22	48
28	22	53	28	22	51	28	22	49	28	22	55
29	22	59	29	22	57	29	22	55	29	23	00
30	23	04	30	23	0.	30	23	01	30	23	05

South Declination. South Declination. South Declination. South Declination.

First.		Second.		Third.		Fourth.	
1649		1650		1651		1652	
1653		1654		1655		1656	
1657		1658		1659		1660	
1661		1662		1663		1664	
1665		1666		1667		1668	
1669		1670		1671		1672	
D. G. M.		D. G. M		D. G. M		D. G. M	
1 23 08		1 23 08		1 23 06		1 23 09	
2 23 13		2 23 12		2 23 10		2 23 14	
3 23 17		3 23 16		3 23 15		3 23 18	
4 23 20		4 23 20		4 23 18		4 23 21	
5 23 23		5 23 23		5 23 21		5 23 24	
6 23 26		6 23 26		6 23 24		6 23 26	
7 23 28		7 23 28		7 23 27		7 23 28	
8 23 29		8 23 29		8 23 29		8 23 30	
9 23 30		9 23 30		9 23 30		9 23 31	
10 23 31		10 23 31		10 23 31		10 23 31½	
11 23 31½		11 23 31½		11 23 31½		11 23 31½	
12 23 31		12 23 31½		12 23 31½		12 23 31	
13 23 30		13 23 31		13 23 31		13 23 30	
14 23 29		14 23 29		14 23 30		14 23 29	
15 23 28		15 23 28		15 23 29		15 23 27	
16 23 25		16 23 26		16 23 27		16 23 25	
17 23 23		17 23 23		17 23 24		17 23 22	
18 23 20		18 23 20		18 23 21		18 23 19	
19 23 16		19 23 17		19 23 18		19 23 15	
20 23 13		20 23 13		20 23 14		20 23 11	
21 23 07		21 23 09		21 23 10		21 23 06	
22 23 02		22 23 04		22 23 05		22 23 01	
23 22 57		23 22 58		23 23 00		23 22 56	
24 22 51		24 22 53		24 22 54		24 22 50	
25 22 44		25 22 47		25 22 48		25 22 43	
26 22 37		26 22 40		26 22 41		26 22 35	
27 22 30		27 22 32		27 22 34		27 22 28	
28 22 22		28 22 24		28 22 27		28 22 20	
29 22 14		29 22 17		29 22 19		29 22 12	
30 22 05		30 22 08		30 22 11		30 22 03	
31 21 56		31 21 58		31 22 02		31 21 54	

South Declination. South Declination. South Declination. South Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M	D.	G.	M	D.	G.	M	D.	G.	M.
1	04	34	1	04	30	1	04	36	1	04	18
2	04	00	2	04	07	2	04	14	2	03	55
3	03	38	3	03	44	3	03	50	3	03	32
4	03	15	4	03	21	4	03	27	4	03	09
5	02	51	5	02	58	5	03	03	5	02	46
6	02	28	6	02	34	6	02	40	6	02	23
7	02	05	7	02	11	7	02	17	7	01	59
8	01	41	8	01	48	8	01	53	8	01	36
9	01	18	9	01	24	9	01	30	9	01	13
10	00	54	10	01	01	10	01	07	10	00	49
11	00	31	11	00	37	11	00	43	11	00	25
12	00	07	12	00	14	12	00	20	12	00	02
13	00	17	13	00	10	13	00	04	13	00	22
14	00	39	14	00	33	14	00	28	14	00	46
15	01	02	15	00	57	15	00	51	15	01	09
16	01	25	16	01	20	16	01	14	16	01	33
17	01	49	17	01	44	17	01	38	17	01	56
18	02	12	18	02	07	18	02	01	18	02	19
19	02	35	19	02	31	19	02	24	19	02	43
20	02	58	20	02	54	20	02	47	20	03	06
21	03	21	21	03	19	21	03	13	21	03	29
22	03	44	22	03	42	22	03	35	22	03	53
23	04	08	23	04	05	23	03	59	23	04	16
24	04	32	24	04	27	24	04	22	24	34	40
25	04	55	25	04	50	25	04	45	25	05	03
26	05	18	26	05	13	26	05	08	26	05	26
27	05	42	27	05	37	27	05	31	27	05	49
28	06	06	28	06	00	28	05	55	28	06	12
29	06	29	29	06	2	29	06	18	29	06	35
30	06	52	30	06	46	30	06	41	30	06	58

North Declination. | South Declination.

North Declination. | South Declination.

North Declination. | South Declination.

North Declination. | South Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M.	D.	G.	M	D.	G.	M	D	G.	M
1	07	15	1	07	09	1	07	04	1	07	21
2	07	37	2	07	32	2	07	26	2	07	44
3	08	00	3	07	55	3	07	49	3	08	07
4	08	22	4	08	17	4	08	11	4	08	29
5	08	45	5	08	39	5	08	34	5	08	51
6	09	07	6	09	02	6	08	57	6	09	13
7	09	29	7	09	23	7	09	19	7	09	35
8	09	50	8	09	45	8	09	41	8	09	57
9	10	12	9	10	08	9	10	02	9	10	19
10	10	35	10	10	30	10	10	24	10	10	41
11	10	56	11	10	52	11	10	46	11	11	02
12	11	18	12	11	12	12	11	07	12	11	23
13	11	39	13	11	34	13	11	29	13	11	44
14	12	00	14	11	55	14	11	50	14	12	05
15	12	21	15	12	16	15	12	11	15	12	26
16	12	41	16	12	37	16	12	32	16	12	47
17	13	01	17	12	57	17	12	52	17	13	07
18	13	21	18	13	17	18	13	12	18	13	27
19	13	41	19	13	37	19	13	32	19	13	47
20	14	01	20	13	57	20	13	53	20	14	07
21	14	21	21	14	17	21	14	12	21	14	26
22	14	40	22	14	37	22	14	31	22	14	45
23	14	59	23	14	56	23	14	50	23	15	04
24	15	18	24	15	15	24	15	09	24	15	23
25	15	37	25	15	33	25	15	28	25	15	42
26	15	55	26	15	52	26	15	46	26	16	00
27	16	13	27	16	10	27	16	05	27	16	18
28	16	31	28	16	28	28	16	23	28	16	36
29	16	49	29	16	46	29	16	40	29	16	54
30	17	06	30	17	03	30	16	58	30	17	11
31	17	23	31	17	20	31	17	15	31	17	27

South Declination. South Declination. South Declination. South Declination.

North Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M	D.	G.	M	D.	G.	M	D.	G.	M
1	22	08	1	22	10	1	22	12	1	22	05
2	22	00	2	22	02	2	22	04	2	21	56
3	21	51	3	21	53	3	21	55	3	21	48
4	21	42	4	21	44	4	21	47	4	21	39
5	21	33	5	21	35	5	21	38	5	21	29
6	21	23	6	21	25	6	21	28	6	21	19
7	21	13	7	21	15	7	21	18	7	21	09
8	21	02	8	21	05	8	21	07	8	20	59
9	20	51	9	20	54	9	20	57	9	20	48
10	20	40	10	20	43	10	20	46	10	20	37
11	20	28	11	20	31	11	20	34	11	20	25
12	20	16	12	20	19	12	20	22	12	20	13
13	20	04	13	20	07	13	20	10	13	20	00
14	19	51	14	19	54	14	19	58	14	19	48
15	19	38	15	19	41	15	19	45	15	19	35
16	19	25	16	19	28	16	19	31	16	19	22
17	19	11	17	19	15	17	19	18	17	19	08
18	18	58	18	19	01	18	19	05	18	18	54
19	18	43	19	18	47	19	18	51	19	18	40
20	18	29	20	18	33	20	18	36	20	18	25
21	18	14	21	18	18	21	18	21	21	18	10
22	18	00	22	18	02	22	18	06	22	17	55
23	17	44	23	17	47	23	17	51	23	17	39
24	17	28	24	17	31	24	17	36	24	17	23
25	17	12	25	17	15	25	17	20	25	17	07
26	16	56	26	17	00	26	17	04	26	16	51
27	16	39	27	16	44	27	16	48	27	16	34
28	16	22	28	16	27	28	16	30	28	16	17
29	16	05	29	16	10	29	16	14	29	16	00
30	15	48	30	15	53	30	15	57	30	15	43
31	15	31	31	15	35	31	15	39	31	15	25

North Declination.

First.			Second.			Third.			Fourth.		
1649			1650			1651			1652		
1653			1654			1655			1656		
1657			1658			1659			1660		
1661			1662			1663			1664		
1665			1666			1667			1668		
1669			1670			1671			1672		
D.	G.	M	D.	G.	M	D.	G.	M	D.	G.	M
1	15	12	1	15	17	1	15	21	1	15	07
2	14	54	2	14	59	2	15	03	2	14	49
3	14	36	3	14	41	3	14	45	3	14	31
4	14	17	4	14	23	4	14	26	4	14	12
5	13	58	5	14	03	5	14	07	5	13	53
6	13	39	6	13	45	6	13	49	6	13	34
7	13	20	7	13	26	7	13	29	7	13	15
8	13	01	8	13	06	8	13	10	8	12	56
9	12	41	9	12	47	9	12	50	9	12	36
10	12	21	10	12	27	10	12	31	10	12	16
11	12	01	11	12	06	11	12	11	11	11	56
12	11	43	12	11	46	12	11	51	12	11	35
13	11	21	13	11	25	13	11	31	13	11	15
14	11	00	14	11	05	14	11	10	14	10	54
15	11	39	15	10	44	15	10	49	15	10	34
16	10	18	16	10	23	16	10	28	16	10	13
17	09	57	17	10	02	17	10	07	17	09	51
18	09	36	18	09	41	18	09	46	18	09	30
19	09	15	19	09	20	19	09	25	19	09	09
20	08	53	20	08	59	20	09	03	20	08	47
21	08	31	21	08	38	21	08	42	21	08	25
22	08	09	22	08	15	22	08	20	22	08	04
23	07	47	23	07	53	23	07	58	23	07	41
24	07	25	24	07	31	24	07	36	24	07	19
25	07	03	25	07	09	25	07	14	25	06	57
26	06	41	26	06	46	26	06	52	26	06	35
27	06	18	27	06	23	27	06	29	27	06	12
28	05	56	28	06	01	28	06	07	28	05	50
29	05	33	29	05	38	29	05	44	29	05	27
30	05	10	30	05	16	30	05	21	30	05	04
31	04	48	31	04	53	31	04	58	31	04	41

paſſes, ſet them upon the graduated Meridian of your Chart, and allowing 20 leagues for every degree that is contained between the two feet of your Compaſſes, the diſtance deſired is thereby known: if between the places there be 5 degrees, then they are 100 leagues aſunder, &c. But if the diſtance between the places be ſo great, as that the Compaſſes cannot reach between them, then take out 5 degrees with your Compaſſes, which is 100 leagues, & therewith you may meaſure the diſtance as practiſe will teach you. There is alſo in every Chart a ſcale of leagues laid down, whereby you may meaſure diſtances, as is commonly uſed.

How doth the Pilot order theſe matters, thereby to conduct his Ship from place to place?

The Pilot in execution of this part of Navigation, doth with careful regard, conſider three eſpecial things, whereupon the full practiſes are grounded.

1 Of which the firſt is, the good obſervation of his latitude, which how it may be known is before ſufficiently expreſſed.

2 The ſecond is a careful regard of his ſteredge, with very diligent examination of the truth of his Compaſſe, that it be without variation or other impediments.

3 And the third is a careful conſideration of the number of leagues, that the Ship ſayleth in every hour or watch, to the neereſt eſtimation that poſſibly he can give; for any two of theſe three practiſes being truly given, the third is thereby likewiſe known.

As by the Courſe and height the diſtance is manifeſted, by the diſtance and Courſe the height is known: by the height and diſtance the Courſe is given, of which three things the Pilot hath only his height in certain: the Courſe is ſomewhat doubtful, and the diſtance is but barely ſuppoſed, notwithſtanding from his altitude and Courſe he concludeth the truth of his practiſe, proceeding in this ſort.

Firſt, he conſidereth in what latitude the place ſtandeth from whence he ſhapeth his Courſe, which for an example ſhall be the Lyzart ſtanding in 50 degrees of Septentrional latitude, then directing his Courſe S. W. ſayleth 3 or 4 dales or longer in ſuch thick weather, as that he is not able to make any obſervation of the Poles altitude, in which time he omitteth not to keep an accompt how many leagues the Ship hath ſailed upon that Courſe as neer as he can gueſſe, which number of leagues in this example ſhall be 100 according to his judgement: then having convenient weather, he obſerveth in what latitude he is, and findeth himſelf to be in 47 degrees, now with his Compaſſes he taketh the diſtance of 100 leagues, which is the quantity of the Ships run by his ſuppoſition, and then ſetting one foot of the Compaſſes upon the Lyzart, which is the place from whence he began his Courſe, and directly South Weſt from the ſame he ſetteth the other point of the Compaſſes, by the direc-

on of another pair of Compaſſes, in ſuch ſort as Coaſes are found, and there he maketh a prick for the place of his Ships being, according to his reckoning and Coaſe.

And now ſearching whether it do agree with his height, (for the eight, Coaſe, and diſtance muſt all agree together) he findeth that his prick ſtandeth in 46 degrees, 26 minutes, but it ſhould ſtand in 47 degrees to agree with his obſervation. Wherefore perceiving that he hath given the Ship too much way, he bringeth his Coaſe and obſerved altitude to agree, and then he ſeeth that his ſhip hath ſailed but 85 leagues, and there he layeth down a prick for the true place of his ſhips being, according to his Coaſe and latitude, for ſo by his Coaſe and height he findeth the truth of his diſtance, and reproveth his ſuppoſed accompt to the 15 leagues too much: and after this ſort he proceedeth from place to place, until he arrive unto his deſired Port: which is a concluſion infallible, if there be no other impediments, (whereof there hath not been good conſideration had) which may breed errour, for from ſuch negligence there may ariſe many inconveniences.

What may thoſe impediments be?

BY experience at the Sea we find many impediments that do diſturbe the expected concluſion of our practice, as that they agree not with the true poſitions of Art. For, Firſt it is a matter not common to have the wind ſo beneficial, as that a ſhip may ſail therby, betwéen any 2 aſſigned places upon the direct coaſe, but that by the contrariety of winds, ſhe may be conſtrained to travers upon all points of the Compaſs, the nature whereof I have before ſufficiently expreſſed.

Secondly, Although the wind may in ſome ſort favour, yet the ſhip may have ſuch a Leward condition, as that ſhe may make her way 2 or 3 points from her caping.

Thirdly, The Sterage may be ſo diſorderly handled, as that thereby the Pilot may be abuſed.

And laſtly, The Compaſs may be ſo varied, as that the Pilot may likewiſe thereby be drawn into errour, at all which things, and many moe, as the nature of his Sayling, whether before the wind, quartering, or by a bowling, or whether with lofty or low ſails, with the benefits or hinderances of the Sea, tydegates, ſtreams, and forced let thereof, &c. Of all which things (I ſay) the skilful Pilot muſt have careful conſideration, which are better learned by practice, than taught by pen, for it is not poſſible that any man can be a good and ſufficient Pilot or skilful Seaman, but by painful and diligent practice, with the aſſiſtance of Art, whereby the famous Pilot may be eſteemed worthy of his Profeſſion as a Member meet for the Common-weale.

And now having ſufficiently ſhewed you the ordering of your Chart, for the execution of the skill of Navigation, and being alſo deſirous that you ſhould effectually underſtand the full nature & uſe of the ſame: I think

think it good by a few queſtions to give you an occaſion to exerciſe your ſelf, in the perfect accompliſhment of ſuch concluſions as are by this excellent and commodious inſtrument to be performed.

Neceſſary Queſtions for the better underſtanding of the commodious uſe of the Chart.

1 Q. IF I ſail 70 leagues upon the Southweſt courſe, I demand how many degrees I ſhall lay or depreſs the Pole?

A. The difference will be 2 degrees, 30 minutes.

2 Q. If in ſayling Weſt Northweſt I raiſe the Pole 3 degrees, 30 minutes, I demand how many leagues I have ſailed?

A. The diſtance ſailed is 180 leagues.

3 Q. If in ſayling 180 leagues between Weſt and North, I raiſe the Pole 3 degrees, I demand upon what Coaſt I have ſayled, and how far I am from the Meridian from whence I began that Coaſt?

A. The Coaſt ſailed is Northweſt by Weſt, and the diſtance from the Meridian is 90 leagues.

4 Q. If in ſayling 154 leagues I be 80 leagues Weſt from the Meridian from whence I began my Coaſt, I demand upon what point of the Compaſs I have ſailed, and how much I have raiſed the Pole?

A. The Coaſt is Northweſt by North, and the Pole is raiſed 6 degrees.

5 Q. If I ſail Northweſt until I be 50 leagues from the Meridian, where I began my Coaſt: I demand how many leagues I have ſailed, and how much the Pole is raiſed?

A. The diſtance ſailed is 71 leagues, and the Pole is raiſed 2 degrees, 32 minutes.

6 Q. If in ſayling W. N. W. I do in 30 hours raiſe 2 degrees, how many degrees ſhould I have raiſed the Pole, if the ſame motion had been North and by Weſt?

A. You ſhould have raiſed 5 degrees.

7 Q. A ſhip ſayling towards the Weſt, for every 80 leagues that ſhe ſayleth in her Coaſt, ſhe departeth from the Meridian from whence ſhe began the ſame Coaſt 45 leagues, I demand upon what point of the Compaſs, and how many leagues ſhe hath ſayled, in raiſing the Pole 5 degrees?

A. She hath ſayled Northweſt by North 120 leagues.

8 Q. A Pilot ſayling toward the Weſt 100 leagues, hath forgotten his Coaſt, yet thus much he knoweth that if he had ſayled upon ſuch a coaſt, as that in 160 leagues ſayling he would have raiſed the Pole 3 degrees, he ſhould then have been twiſe as far from the Meridian as now he is, and ſhould alſo have 4 degrees further to the Northward then now he is, I would now know what coaſt he hath ſayled, how many leagues, and how far he is ſeparated from the Meridian, from whence he began the ſaid coaſt?

A. Shee hath sayled 88 leagues Northwest by west, & is 73 leagues from the Meridian nearest.

9 Q. Two ships departing from one place, the one sayling 143 leagues towards the west, hath raised the Pole 4 degrees, and the other hath raised the Pole 7 degrees, and is 95 leagues West from the Meridian of the place from whence he began his course, I demand by what course the said ship hath sayled, and how far they be asunder, and by what course they may meet?

A. The first ship hath sayled Northwest by west, the second hath sayled Northwest by north 170 leagues, they are asunder 65 leagues, and the course betwéen them is North northeast, and South southwest.

10 Q. Two ships sayling from one place, the one in sayling 180 leagues, is to the Eastward of the Meridian where he began his course 150 leagues, I demand upon what course, & how many leagues the other ship shal sayl, to bring himself 50 leagues N. by W. from the first ship?

A. The first ship hath sayled N. E. by E. and hath raised the Pole 5 degrées, the second ship must sayl Northeast by North 237 leagues.

ALthough it may seem (to some that are very expert in Navigation) that these Questions are needlesse, and without use, being so plain as not deserving in this sort to be published, notwithstanding that their Opinion, I do in friendly courtesie advise all young Practisers of this excellent Art of Sayling, that they do not only by their Charts prove the truth of these answered Questions, but also endeavour themselves to propound divers other sorts of Questions, and in seeking their Answers to enter into the Reason thereof: for by such exercise, the young beginner shall understand the substantial grounds of his Chart, and grow perfect therein: for whose ease and furtherance only, I have at this present Published this brief Treatise of Navigation, knowing that the expert Pilot is not unfurnished of these Principles, but every little help doth greatly further in every beginning: And therefore for the further benefit of the Practiser, I have hereunto annexed a particular Sea Chart of our Channel, commonly called the Sleve, by which all that is before spoken as touching the use of the Chart, may be practised, wherein the depths of the Channel are truely laid down: being an Instrument most commodious and necessary for all such as seek the Chan-

nel.

nel comming out of the Ocean Sea, much of it is from my own practice, the reſt from Pilots of very good ſufficiency; I have found great certainty by the uſe of this Chart, for by the Altitude and depth I have not at no time miſſed the true notice of my Ships being, which (through Gods merciful favour) by my lands falls I have found alwayes to be without terrour, therefore have it not in light regard, for it will give you great evidence, and is worthy to be kept as a ſpecial jewel for the Seamans uſe, be he never ſo expert.

And thus having ſufficiently expreſſed all the practiſes appertaining to the skill of Horizontal Navigation, which kind of Sayling is now of the greateſt ſort only practiſed; I think it good for your better memory, briefly to report that which before is ſpoken as touching this kind of Navigation, and withal it will not be amiſſe to ſhew you after what ſort I have been accuſtomed to keep my Accompts in my practiſes of Sayling, which you ſhall find to be very ſure, plain, and eaſie, whereby you may at all times examine what is paſt, and ſo reform the cauſes laid down upon the Chart, if by chance there ſhould any errour be committed. And ſo concluding this part of Navigation, will in the next Treatiſe make known unto you the uſe of the Globe, ſuch uſes I mean as the Seaman may practice in his Voyages, and that are moſt neceſſary for his knowledge.

A Table

A Table shewing the Order how the Seamen may keep his Accompts, whereby he may at all times distinctly examine his former practises, for in every 24 hours, which is from noon to noon, he doth not only lay down his Latitude, with the Corse and Leagues, but also how the Wind hath blown in the same time.

The first Column is the months and dayes of the same; the second is the observed Altitude, the third is the Horizontal Corse or motion of the Ship, the fourth the number of Leagues that the Ship hath sayled, the fifth is a space wherein must be noted, by what Wind those things have been performed; and the next great space is to lay down any brief Discourse for your memory.

Anno. 1593.

Moneths and dayes of the Moneth.	Latitude. G.	M.	Corse.	Leagus	Wind	
March. 24	7	30	N. N. E.	25	East.	The 13 of *March* cape S *Augustin* in *Brasil*, being 16 leagues East from me, I began this accompt.
25	5	44	N. b. E. nor.	36	E b. N.	*Compasse varied 9 degrees the South point westward.*
26	4	1	N. b. N.	35	E. b. N.	
27	2	49	N.	24	E. b. N.	*Compasse varied 8 degrees, the South point westward.*
28	1	31	N. easterly.	26	E. b. N.	
29	1	4	N. N. W.	9	N. E.	
April. 31	0	0	N. b. W.	21	E N E.	*Compasse varied 6. deg. 40. min. the South point westward.*
4	0	39	N W. b. N.	15	N. E.	
7	1	53	N. N. W.	28	N. E.	*Observation, the Pole Artick above the Horizon.*
9	3	5	N. W. b. N	30	N. e. b. E	
10	4	5	N. W. b. N.	22	N. e.	
11	4	45	N. W.	18	N. e. b. N	
12	5	16	N. W.	14	N. e. b. N	*Compasse varied 7. degrees, the North point Eastward.*
13	6	11	N. W. b. N.	23	N. e.	
14	7	36	N. W. b. N.	24	N. e.	

A brief Repetition of that which is before spoken.

There are three kinds of Navigation, Horizontal, Paradoxal, and sayling upon a great Circle, performed by Corse and Travers.

A Corse is the paradoxal line, which is described by the ships motion upon any point of the Compass.

A Travers is the variety of the ships motion upon every alteration of Corses.

The Compass is an artificial Horizon, by which Corses and Traverses are directed, and containeth 12 points, and every point containeth 11¼ degrees, or 45 minutes, being ¾ of an hour.

By such quantity of time as the Moon separateth her self from the Sun, by the like rate of time every tide doth one differ from another.

In every hour the tyde altereth two minutes, in every flood 12 min. and in every ebbe 12 min. and in every day 48 minutes, because that so is the Moons separation from the Sun: for the Moon doth separate her self from the Sun, in every day one point and 3 minutes, between the Change and the Full she is to the Eastwards of the Sun, and then is her separation, at which time she is before the Sun in respect of her natural motion, but in regard of her violent motion, she is then behind or abaft the Sun.

Between the Full & Change, she is to the westward of the Sun, applying towards the Sun, and then is her application, at which time she is behind or abaft the Sun, in respect of her natural motion, but in consideration of her violent motion, she is then before the Sun.

She hath a violent motion, a natural motion, a slow, swift, and mean motion.

In every 27 dayes and 8 hours, she performeth her natural motion through the Zodiack.

Between Change and Change there is 29 dayes, 12 hours, 44 minutes neerest.

The Solar yeer consisteth of 12 months, and the Lunar yeer of 12 Moons.

The Moons Age is found by the Epact.

All Instruments used in Navigation, of what shape or form soever they be, are described or demonstrated upon a Circle, or some portion of a circle, and therefore are of the nature of a Circle.

A Degree is the 360 part of a Circle, how big or little soever the Circle be.

A Degree is applyed after the 6 several sorts, to the Equator, to the Meridian, to the Horizon, to the vertical Circle, to Measure, to Time.

Altitude is the distance, height, or mounting of one thing above another.

The Poles Altitude is the distance between the Pole and the Horizon, or the portion of the Meridian which is contained between the Pole and the Horizon.

The

The Altitude of the Sunn above the Horizon, is that portion of the vertical circle, which is contained betweæn the Horizon and the Sun.

Latitude, is that ark of Meridian which is contained betweæn the Parallel of any place and the Equator, or that part of the Meridian which is included betweæn the Zenith and the Equinoctial.

Longitude, is that portion of the Equator contained betweæn the Meridian of S. Michels, one of the Iles of the Assores, and the Meridian of the place whose longitude is desired: the reason why the accompt of the longitude doth begin at this Ile, is because that there the Compass hath no variety, for the Meridian of this Ile passeth by the poles of the world, & the poles of the Magnet, being a meridian proper to both poles.

The Longitude betweæn place and place, is the portion of the Equator, which is contained betweæn the Meridian of the same places.

Declination is the distance of the Sun, Moon, and Stars, from the Equinoctial, or that part of the Meridian which passeth by the Center of any celestial body, and is contained betweæn the same center and the Equinoctial.

Hidrography is the description of the Ocean Sea, with all Iles, Bancks, Rocks, and Sands therein contained, whose limits extend to the Geographical borders of the earth, the perfect notice whereof is the chiefest thing required in a sufficient Pilot, in his excellent practise of Sayling.

Geography is the description of the earth only, whereby the terrestrial form in his due situation is given, whose distinction is by mountains, rivers, vallies, cities, and places of fame, without regard of Circles, Climats, and Zones.

Cosmography is the description of the Heavens, with all that is contained within the circuit thereof, but to the purpose of Navigation, we must understand Cosmography to be the universal description of the terrestrial Globe, distinguished by all such circles, by which the distinction of the celestial Sphere is understood to be given, with every Country, Coast, Sea, Harborow, or other place seated in their due longitude, latitude, zone, and clyme.

The Chart is a special Instrument in Navigation, pretending the Cosmographical description of the terrestrial Globe, by all such lines, circles, colles, and divisions as are required to the most exquisite skill of Navigation.

THE SECOND PART OF THIS TREATISE OF NAVIGATION.

WHEREIN IS TAUGHT the nature and moſt neceſſary uſe of the Globe, with the Circle, Zones, Climates, and other diſtinctions, to the perfect uſe of SAYLING.

By which moſt excellent Inſtrument is performed all that is needfully required to the full perfection of all the Three kinds of NAVIGATION.

LONDON,
Printed by *Gartrude Dawſon*, living in *Bartholomews* Cloſe, the ſecond door from the *Half Moon* Tavern's Alley that goes into *Alderſgate*-ſtreet, 1657.

Meridian.
Circle
Horizon.

THE SECOND BOOKE OF THE *SEAMANS SECRETS.*

What is the Sphere?

THe Sphere is a solid body contained under one superficies, in the middest whereof there is a point or prick, which is the center of the Sphere, from whence all right lines drawn to the circumference, are equal the one to the other, whereby it is to be understood, that the center of the sphere is evenly placed in his midst, as that it hath like distance from all parts of the circumference. And forasmuch as the Sphere is an Instrument demonstrating unto us the universal Engine of the world, we must therefore understand the Center to be this Terrestial Globe wherein we have our being, which compared to the Celestial Globe or heavenly Circumference doth here proportion, as the Center to his Circle: which earthly Globe by the Divine mighty workmanship of God, doth admirably hang upon his center, being of equal distance from all parts of the Circumference.

What are the distinctions of the Sphere?

THe Sphere is distinguished by the ten Circles, whereof 6 are great Circles, and 4 are lesse circles: whereof there are only 8 described upon the body of the Globe, limiting the Zones and motion of the Planets, as the Equinoctial, the Ecliptick, the Equinoctial Colure, the Solsticial Colure, the Tropick of Cancer, the Tropick of Capricorn, the Artick Polar Circle, and the Antartick Polar circle. The Horizon and Meridian are not described upon the body of the Globe, but artificially annexed thereunto, for the better perfection of his use.

Which are the greater Circles, and which the lesser?

THe Equator, the Ecliptick, the 2 Colures, the Meridian and the Horizon, are great Circles, because they divide the Sphere into 2 equal parts. The 2 Tropicks, the Polar circles, are lesser circles, because they devide the Sphere into two unequal parts.

Which is the Equator, or Equinoctial?

THe Equinoctial is a great Circle dividing the Sphere into two equal parts, leaving the one half towards the North, and the other half towards the South, and is equally distant from both the Poles of the world 90 degrees, placed evenly between them, and described upon

them, this line crosseth the horizon in the true points of E. & W. & hath alwayes the one half above the Horizon, unless it be under either of the poles, for there the equator is in the horizon: it crosseth the Meridian at right sphere angles, & it also crosseth the ecliptick line in the 1 min. of ♈ & ♎, dividing the ecliptick & horizon, & is also by them divided into two equal parts: this line is also divided into 360 equal parts or deg. which are the deg. of longit. beginning the account in the point of ♈, reckoning towards the East, concluding the number 360 in the place where the first account began, viz. where the equator doth intersect the ecliptick in the 1 min. of ♈, under which meridian S. Mihels one of the Iles of the Assores to be placed in the Geographical description of the terrestrial Globe.

What is the use of the Equator?

THe Use of the Equinoctial, is to know the declination of the Sun, Moon, & Stars, whereby the latitude of place is given, for that portion of the Meridian which is contained betwen the equator & the center of the Sun, Moon, or Stars, is their declination: Also by the Equinoctial is known the longit. of places, for a quarter of a great circle being drawn from the pole, to the place whose longit. is desired, & so continued to the equinoctial, that deg. & min. in which the quarter circle doth touch the equator, is the longit. of the place, or if you bring any place (that is described upon the globe) whose longit. you would know, under the meridian of the globe, that deg. of the equinoctial that is then likewise directed under the meridian, is the longit. desired: when the sun cometh upon the equator, then the days & nights are of one length throughout the whole world, & then the sun riseth upon the true point of E. & seteth upon the true point of the W. & not els at any time: this circle being fixed in the firmament is moved with the first mover in every hour 15 deg. by which account in 24 hours his motion is performed. And here note, that the deg. of the equinoctial have a double application, the one to time, & the other to measure: in respect of time 15 deg. make an hour, so that every deg. containeth but 4 min. of time, but when his deg. have relation to measure, then every deg. containeth 60 min. being 20 leag. of that every min. standeth for a mile after our English account. But this allowance of 20 leag. to every deg. of the equinoctial, in sayling or measuring of distances upon the E. & W. coasts is only when you are under the same, because the equinoctial being a parallel, is likewise a great circle, & every deg. of a great circle is truly accounted for 10 leag. or 60 miles. But in the rest of the parallels where either of the poles are elevated above the horizon, if there you sayl or measure upō the coasts of E. or W. there are not 20 leag. to be allowed to every deg. because such parallels are lesser circles, therefore they have the fewer nūber of leag. to every deg. so that the farther you depart frō the equator, the lesser are the parallels, & the lesser any parallel is, the lesser are his deg. because every circle cōtaineth 560 deg. & as the circles & deg. are diminished in their quātity, in like sort the distance answerabl to such degrees must abate, as their circles do decrease, & further know, that the equator, is the beginning of all terrestrial latitude, & declination of the celestial bodies.

What

What is the Ecliptick?

THe Ecliptick line is a great circle, deviding the ſphere into 2 equal parts, by croſſing the equator, in oblique ſort deviding him, & being devided by him into 2 equal parts, běding frō the equator towards the ♑. & ♋. 23 deg. & 28 min. being in the 1 min. of ♋ & ♈, there determining the tropicall limits, this line likewiſe devideth the zodiack, by longit. into 12 equal parts, & is devided together with the Zodiack, into 12 equal portions, called ſigns, & every of theſe ſigns is devided upon the ecliptick into 30 equal parts or deg. ſo that this line is devided into 360 deg. upō which line the cēter of the ſun doth cōtinually move: this circle is deſcribed upon his proper poles, namely the pole of the zodiac, being in all his parts 90 deg. frō either of thē: The zodiac is a circle contrary to all, for they are mathematical lines, cōſiſting only of length, without breadth or thickneſs: but the zodiac hath latit. or breadth 12 deg. whoſe limits are 6 deg. of either ſide of the ecliptick, wherin the ſun, moon, & plāets perform their motiōs & revolutiōs, the cēter of the ſun only kēping upō the ecliptick, but the other plāets have ſometime ♌ lat. & ſometime ♑. lat. And here you muſt underſtād, that the lat of the plāets or ſtars, is that portiō of the ecliptical meridian which is contained betwæn the center of the plāet or ſtar, & the ecliptick line, & their longit. is that portion of the line ecliptick, which is contained betwæn the ſaid meridian & the ecliptical meridian that palleth by the poles of the zodiac, & the firſt min. of Aries.

The 12 diviſions or ſigns of the zodiac are theſe, Aries ♈, Taurus ♉, Gemini ♊, Cancer ♋, Leo ♌, Virgo ♍, Libra ♎, Scorpio ♏ Sagittari ♐. Capricorn ♑. Aquarius ♒. Piſces ♓: & theſe are their characters that ſtand by them. The 7 Planets that kēp within the limit of the Zodiac, are theſe, Saturn ♄. Jupiter ♃, Mars ♂, Sol ☉, Venus ♀, Mercury ☿, Luna ☽, ♄ performs his courſe through all the deg. of the zodiac once in every 30 years: ♃ in 12 years: ♂ in 2 years: ☉ in 365 days & 6 hours, being one year: ♀ & ☿ as ☉: & ☽ performeth her courſe in 29 days & about 8 hours, through all the deg. of the zodiac. And note that this natural motion of the plāets in the zodiac is from the W. toward the E. the diurnal motion is violent, cauſed by the firſt mover, or primum mobile, who in every 24 h. doth perform his circular motion from the E. to the W. carrying with him all other inferiour bodies whatſoever.

What is the uſe of the Zodiack?

BY the Zodiac & Ecliptick is known the longit. & latit. of any celeſtial body, either plāets or fixed ſtars, for a quarter of a great circle drawn from the pole of the zodiac to the cēter of any plāet or ſtar, & ſo continued until it touch the ecliptick, that deg. & min. where the ſaid quarter-circle toucheth the ecliptick, is the longit. of the ſaid body, which is to be accōpted from the firſt min. of ♈, for the longit. of ♈ is the portion of the ecliptick line, which is contained betwæn the ecliptical meridian paſſing by the poles of the zodiac, and the firſt min. of ♈, & the ecliptical meridian which palleth by the poles of the zodiac & the center of any planet or ſtar.

When

When the Planets are upon the northside of the ecliptick, they have north latitude, & being south from the ecliptick, they have south latitude. Also the motions of the Planets, the time of any Eclipse, & the Suns declination by his place in the ecliptick, are known by this circle, whose use is very ample, & to great purpose for all astronomical considerations.

What are the Colures?

THe Solsticial Colure is a great circle passing by the Poles of the world, and the Poles of the Zodiack, and the Solsticial points or first min. of Capricorn and Cancer, cutting the Equinoctial at right Spherick angles, in his 90 and in his 270 degrees.

The Equinoctial Colure is likewise a great Circle passing by the Poles of the world, and the Equinoctial point of Aries and Libra, and crolleth the Equator in his 1 and 18 degrees, and these colures do interset each other in the poles of the world to the right Spherick angles.

What is the use of these Colures?

THeir use is to distinguish the four principal seasons of the year, Spring, Summer, Autumne, and Winter, dividing the Equator and Ecliptick into 4 equal parts: also that Ark of the Solsticial Colure, which is included between the first minute of Cancer, & the Equinoctial, is the Suns greatest declination toward the north, the like ark being between the tropical point of ♈, & the equator, is the Suns greatest south declination, being in these our dayes 23 deg. 28 min.

What is the Tropick of Cancer?

THe Tropick of Cancer, is one of the lesser Circles devviding the Sphere into two unequal parts, and is described upon the pole Artick, a parallel to the Equator 23 degrees, 28 minutes from him, being the farthest limit of the Ecliptick bending towards the north, to which when the Sun cometh, the days are then longest to all those that inhabit the North parts of the world, & shortest to the Southern inhabitants: between this Circle and the Equator are concluded the 6 septentrional signes, Aries, Taurus, Gemini, Cancer, Leo, Virgo, in which signs during the time that the Sun abideth, being from the 11 of March to the 13 of September, he hath North declination, and then is the Spring and Summer to all such as inhabit in the north parts of the world: and Autumne and Winter to the Inhabitants of the south parts of the world: this circle doth touch the Ecliptick in the first minute of Cancer, where the Sun beginneth his return toward the south, whereupon it took the name Tropick, which signifieth conversion or return, by which point of the Ecliptick, the diurnal motion describeth this circle.

What

What is the Tropick of Capricorne?

THe Tropick of Capricorn is one of the lesser Circles dividing the Sphere into two unequal parts, and is described upon the Pole Antartick a parallel to the Equinoctial 23 degrees, 28 minutes from him, being the farthest bending of the Ecliptick towards the south, to which when the Sun cometh, the dayes are then longest to all those that inhabit in the south parts of the world, and the shortest to the northern Inhabitants: between this Circle and the Equator are included the 6 southern signs, Libra, Scorpio, Sagittarius, Capricorn, Aquarius, Pisces; in which signes, during the time that the Sun abideth, being from the 13 of September to the 11 of March, he hath south declination, & then is the Spring & the Summer to all such as inhabit the south parts of the world: & Autumne & Winter to all the Inhabitants in the north parts of the world: this circle toucheth the ecliptick in the first minute of Capricorn, by which point the diurnal motion describeth this parallel.

What is the use of the Tropicks?

BY the Tropicks the Suns declination is known, as also the Tropicks by the Suns farthest motion towards the north and south, for so much as the Tropicks are distant from the Equator, so much is the Suns greatest declination: and such as is the Suns greatest declining. such is the distance between the Tropicks & the Equator: they are also the limits of the burning Zone, separating the burning and temperate Zones For between the two Tropicks, is contained the burning Zone.

What is the Artick polar Circle?

THe Artick polar Circle is one of the lesser Circles, dividing the Sphere into two unequal parts, and described upon the pole Artick in parallel, to the Tropick of Cancer, having such distance from the pole as the Tropick hath from the Equator, being 23 deg. 28 min. upon which circle the Artick pole of the Zodiack is placed, which being fixed in the firmament, by the vertue of the first mover is carried about with the heavens, by which motion this Circle is described.

What is the Antartick Polar Circle?

THe Antartick polar Circle is opposite to the Artick, and parallel to the Tropick of Capricorn, being in all respect of such distance and description, from and about the Pole Antartick, as the Artick polar Circle is about the pole Artick.

What is the Vse of Artick and Antartick polar Circles?

THe Use of these two polar Circles, is to shew the distance of the Poles of the Zodiack, from the Poles of the World, for so much as

the

the Solſticial points are diſtant from the Equator, ſo much are the Poles of the Zodiack from the Poles of the World: the Circles do alſo divide and limit the temperate & frozen Zones, for betweẽ the Tropick of Cancer & the Artick polar Circle is contained the Northern temperate Zone, & betweẽ the Artick polar Circle & the pole Artick, that is within the Artick polar circle is contained the Northern frozen zone. Alſo betweẽ the tropick of Capricorn & the Antartick polar circle, is contained the Southern temperate Zone, and within the ſaid polar Circle, is included the Antartick frozen Zone: And theſe are all the Circles that are deſcribed upon the body of the Globe.

What is the Meridian?

THe Meridian is a great Circle paſſing by the Poles of the World, & by your Zenith, dividing the Horizon into two equal parts, in the points North and South: it alſo divideth the Sphere with all the paralel Circles therein contained, into two equal parts, croſſing them at right Spherick angles. And this Meridian is not fixed in the firmament as the reſt of the Circles are, for if it were, then ſhould it be moved with the firſt mover as the reſt are, but it is not ſo: therefore the Meridian is manifeſted upon the Globe by a Circle or Ring of Copper faſtned unto the Globe upon the two Poles, ſo that the Globe moveth round upon the two Poles within the Meridian: this Meridian is graduated in every of his quarters into 90 degrees, by which his uſe is performed: and note, that one Meridian may have many Horizons, yet every Horizon hath but one Meridian; for if you travel South or North, you keep ſtill upon the ſame Meridian, yet in every ſenſible difference of diſtance you ſhall enter into a change of Horizons, for there be as many Horizons as there be ſenſible differences of diſtance; and there be as many Meridians as there be ſenſible differences of diſtance, ſo that the difference be not upon the points North & South: but this Copper Meridian annexed to the Globe is to be applyed to all differences & diſtances whatſoever, as amply as if the number were infinite.

What is the uſe of the Meridian?

THe Uſe of the Meridian is to know the higheſt aſcending of the Sun, Moon, or Stars from the Horizon, for when they be upon the Meridian, then are they fartheſt from the Horizon, and then is the moſt convenient time to take the Altitude of the Sun or Stars, whereby to find the Poles elevation.

By the Meridian of your Globe is known the latitude & longitude of any place upon the Globe contained, for if you bring any place under the Meridian, the degrees of the Meridian do ſhew the latitude of the ſame, and that degree of the Equator, which the Meridian doth croſs is the longitude, &c.

What is the Horizon?

THe Horizon is a great Circle dividing the Heavens into two equal parts, the one half being above the Horizon is always in ſight, the other half is not ſeen being under the Horizon, and therefore is called the

finitor

limito; or limit of our sight, for where the heavens and seas seem to joyn together, that is the horizon: the horizon is not fixed in the firmament, & yet is a fixed circle constant to his proper latitude, but because in the Globe one and the same horizon may perform whatsoever is required to all elevations, the horizon is so artificially annexed to the Globe, that by the motion of the Meridian, in the same there faulteth nothing in his use: and the horizons in all respects distinguished, as in the Sea Compass. There are two kinds of horizons, a right horizon, and an oblique horizon: when the Poles are in the horizon, then it is a right horizon, for then the Equator doth cut the horizon to right angles, making a right sphere and a right horizon: an oblique horizon is where either of the poles are elevated above the same, for then the equator doth cut the horizon to unlike angles, making an oblique sphere, and an oblique horizon, and although the horizons be divers and many in number, for every sensible difference of distance hath his proper horizon, yet is the horizon of the Globe so conveniently annexed thereunto, as that by the moving of the Meridian in the horizon, & by the Globes motion in the Meridian, both the Horizon and the Meridian are to be applyed as proper to all places whatsoever, and note that the place where you are, is alwayes the center of the plain superficial horizon.

What is the use of the Horizon?

THe Horizon is the beginning of all altitude, for whatsoever is above the horizon, is said to have altitude more or less, and by the horizon such altitudes are given with help of the Crosse staffe, for placing the Crosse staffe at your eye, if by the one end of the transversary you see the horizon, and by the other end (at the same instant) you see the body observed, then doth the transversary shew upon the staffe the altitude desired, by the horizon, the Navigable courses from place to place are likewise known, as also the quantity of the rising and setting of the Sun, Moon, & Stars: whereby is known the length of the dayes & nights in all climates & at all seasons: by the horizon is known upon what degree of Azumuth the Sun, Moon, or Stars are, when they may be seen, in what part of the heaven soever, whereby the variation of the Compass is found, and the Poles Altitude may at all seasons be given.

Are these all the Circles appertaining to the Globe?

THere are other circles which are fixed & do properly appertain to every particular Horizon, as Azumuths, Almicanters, the Artick, and Antartick Circles.

What are Circles of Azumuth?

CIrcles of Azumuths, or vertical circles, are quarters of great circles, concurring together in the Zenith, as the Meridians do in the pole, and are extended from the Zenith to every degree of the horizon, &c. And because they cannot be conveniently described upon the Globe to be applyed to all horizons, therefore upon the meridian of the Globe there is a piece of copper artificially placed, to be removed to any degree of the

Meridian at pleasure, which piece of Copper representeth the Zenith and must alway be placed so many degrees from the equator, as the pole is elevated from the horizon, and unto this zenith there is joyned a quarter of a great circle called quarta altitudo, the end whereof doth continually touch the horizon, & is so joyned to the zenith, as that it may be moved round about the horizon, and to every part thereof at your pleasure: this quarta altitudo is devided into 90 degrees, being the distinction of all Altitude, and beginning the account from the horizon, which is the beginning of Altitude, and concludeth 90 degrees in the Zenith, being the end and extreme limit of all Altitude.

What are Almicanters?

ALmicanters or Circles of Altitude, or parallel circles to the Horizon and are described upon the Zenith, as the parallels to the equator, are described upon the poles, of which circles there are 90 answerable to the distinctions of the quarta altitudo which are the degrees contained between the horizon and zenith, these circles cannot be described upon the Globe, to be applyed to every horizon, but they are distinguished by the circular motion of the quarta altitudo, for if I desire to see the Almicanter circle of 10 degrees, by moving the quarta altitudo round about the horizon, the zenith degree of their quarter circle, doth shew the Almicanter desired, in what elevation soever.

What is the use of these two Circles?

THe Quarta altitudo performeth the use of both, by the quarta altitudo and horizon, the courses from place to place are known according to the true horizontal position, as hereafter shall plainly appear: it also sheweth the degree of Azumuth, and observed altitude of any celestial body, in what latitude soever: by the Quarta altitudo and Horizon, you may describe a paradoxal Compass upon the Globe, the poles height is at all times thereby to be known, and the variation of the Compass is thereby likewise given, as hereafter in the practise you shall be taught.

What are the Artick and Antartick Circles?

EVery horizon hath his proper artick or antartick Circle, those horizons that have the pole artick elevated above them, have their proper artick circle, and those that have the South pole elevated, have their proper antartick circle, the quantity of which circle is according to the poles elevation, for if the pole be much elevated, then is the artick circle great, for the Poles altitude is the semidiameter of this circle, if the Pole be in the Zenith, then half the heavens is the artick Circle.

What is the use of this Circle?

IF the Sun, Moon, or any Stars be within this Circle, they are never carried under the Horizon during the time of their abode therein, whereupon it cometh to pass, that such as travel far towards the north, have the Sun in continual view, and those that inhabit under the Pole (if any do) the Sun is in continual light for six months together, because the six septentrional signs are within the Artick Circle, the Equator being in the horizon, &c.

There

There is another ſmall Circle, which is called Circulus horarius, or the hour circle, to be annexed to the Meridian of the Globe, for the perfection of his uſe, this circle muſt be devided into 24 equal parts, or hours, and theſe again into ſuch parts as you pleaſe for the better diſtinction of time: this circle muſt be faſtned to the Meridian, ſo that the hours 12 muſt ſtand directly upon the edge of the Meridian, & the pole muſt be the center of this Circle, upon which pole there muſt be faſtened an Inder to move poſitionably as the Sphere (upon any occaſion) ſhall be moved. There is alſo an half Circle, called the Circle of Poſition, which ſith it ſerveth to no great purpoſe for Navigation, I here omit, and thus is the Globe fully finiſhed for the perfection of this uſe.

What are the Poles of the World?

THere are two Poles, the North Artick pole, and the South, or Antartick pole, which poles are two immoveable pricks fixed in the firmament, whereupon the Sphere is moved by vertue of the firſt mover, and are the limits of the Axis of the world, as alſo the extreme term or band of all declination, being 90 deg. from all parts of the Equator.

By the raiſing of the Pole from the horizon, is known the parallel or latitude of our being, it alſo giveth the quantity of the Artick circle, and obliquity of the Sphere.

What is the Axis of the World?

THe Axis of the World is a right line paſſing by the Center of the Sphere, & limitted in the circumference, about the which the ſphere moveth, and is therefore called the Axis of the ſphere, & as all lines commenſurable are limited between 2 points or pricks, ſo is the Axis of the world, & thoſe 2 limiting pricks are called the Poles of the World.

What are the Poles of the Zodiack?

THe Zodiack hath likewiſe two Poles, Artick & Antartick, being 2 pricks fixed in the firmament, limiting the Axis of the zodiack, & are diſtant from the poles of the world 23 deg. 28 min. which poles by the motion of the ſphere do deſcribe the poles circles, performing their motion about the poles of the world in every 24 hours, by vertue of the firſt mover, upon theſe poles the ecliptick, & zodiack is deſcribed: alſo a quarter of a great circle graduated into 90 deg. being faſtened to either of theſe poles & brought to the center of the Star, ſheweth by that graduation the latitude of the ſame ſtar, & where the quarter circle toucheth the Ecliptick, that is likewiſe his longitude: alſo the 7 Planets do perform their natural revolutions upon theſe poles, whoſe motion is from the Weſt towards the Eaſt, contrary to the motion of the firſt mover.

What is the Axis of the Zodiack?

THe Axis of the Zodiack, is a right line paſſing by the center of the Sphere, & limited in the circumference, whoſe limiting points are the poles of the zodiack, and his Axis is moved by the Sphere as are his Poles.

What are the Poles of the Horizon?

THere are two Poles of the Horizon, which are the limits of his perpendicular dimetient being equi-distant 90 degrees from all parts of the horizon, & are the extreme limits of all altitude, that Pole which is in the upper hemisphere is called the Zenith, and his opposite Pole is called Nadir, they are extended in the firmament, but not fixed in it, for they move never, but remain alwayes stable to their proper horizon, which could not be if it were fixed in the firmament, for then should they be moved with the firmament as the rest are, by the help of these poles is found the Azumuth and Almicanter of any celestial body, for a quarter circle devided into 90 degrees, and fixed to the Zenith as is the quarta altitudo, being moved to any celestial body, doth by those deg. shew the almicanter or altitude of the same body from the horizon, & that part of the horizon which the quarter circle teacheth, is the Azumuth of the same body; always provided that the Zenith stand answerable to the poles elevation. that is, so many degrees from the equator, as the Pole is from the Horizon.

How

How many Zones be there?

THere are Five Zones, Two Temperate Zones, Two Frozen Zones, & one burning Zone: the burning zone lieth betwæn 2 tropicks, whose latitute is 46 deg. 56 min. which zone by ancient Geographers is reported to be not habitable, by reason of the great heat, which there they supposed to be, through the perpendicularity of the suns beams, whose perpetual motion is within the said zone, but we find in our travels, contrary to their report, that it is not only habitable, but very populous, containing many famous and mighty Nations, & yeldeth in great plety the most purest things that by natures benefits the earth may procreat: Twice I have sayled through the Zone, which I found in no sort to be offensive, but rather comfortable unto nature, the extremity of whose heat is not furious, but tollerable, whose greatest force lasteth but 6 hours, that is from 9 of the clock in the morning, unto 3 in the afternoon, the rest of the day and night is most pleasing and delightful: therefore they did nature wrong in their rash report.

Of the Frozen Zones.

THe Frozen Zones are contained within the Polar circle, the Artick Frozen Zone within the Artick Polar circle, & the Antartick frozen zone within the Antartick polar circle, which are also reported not to be habitable, by reason of the great extremity of cold, supposed to be in those parts, because of the Suns far distance from those zones, but in these our dayes we find by experience that the ancient Geographers had not the true consideration of the nature of these zones, for thræ times I have bæn within the Artick frozen Zone, where I have found the ayr very temperate, sea and many times in calm weather marvellous hot: I have felt the Suns beams of as forcible action within the frozen zone in calms nær unto the shore, as I have at any time found within the burning zone: this zone is also inhabited with people of good stature, shape, and tractable conditions, with whom I have conversed, and not found them rudely barbarous, as I have found the Canibals which are in the Straits of Magilane, and Southern parts of America: In the frozen zone I discovered a Coast which I named Desolation, at the first view thereof, supposing it by the loathsome shape to be waste and desolate, but when I came to Anchor within the Harbors thereof, the People presently came unto me without fear, offering such poor things as they had to Exchange for Iron Naile, & such like: but the Canibals of America flie the presence of men, shewing themselves in nothing to differ from brute beasts: thus by experience it is most manifest that those zones which have bæn esteemed desolate & waste, are habitable, inhabited & fruitful. If any man be perswaded to the cõtrary of this truth, he shall do himself wrong in having so base an imagination of the excellency of Gods Creation, as to think that God Creating the world for mans use, and the same being devided but into 5 parts, thræ of those parts should be to no purpose:

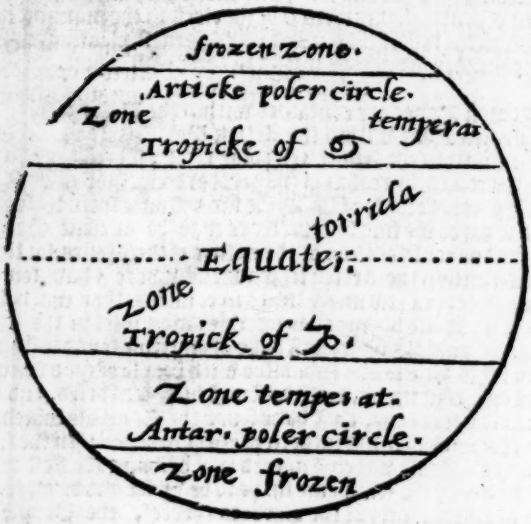
But

But let this saying therefore of the Prophet Esay be your full satisfaction, to confirm that which by experience I have truly spoken: For thus saith the Lord that created heaven, God himself that framed the earth, and made it, he that prepared it, he created it not in vain, he framed it to be inhabited, &c. Esay 45. 18.

Of the Temperate Zones.

The Temperate Artick Zone is included betwéen the Tropick of ♋ and the Artick Polar circle, whose latitude or breadth is 42 deg. 2 min. within the which we have our habitation.

The Temperate Antartick Zone is limited by the Tropick of ♑, & the Antartick Poler circle, & hath breadth or latitude 42 deg. 2 min.



What is a Climat?

A Climate is the space or difference upon the upper face of the earth, included betwéen two parallels, wherein the day is sensibly lengthened or shortened half an hour. for as you travel from the Equator towards the Artick Pole, the Sun having North declination, the dayes do grow longer and longer until at last the Sun not setting under the Horizon, you shall have continual day, and every space or distance that altereth

tereth the day half an hour, is called a Climate: these Climates take their names from such famous places as are within the said Climates, of which there are Nine, as by their distinctions may appear.

1 The first passing through Meroe, beginneth in the latitude of 12 deg. 45 min. & endeth in 12 deg. 30 min. whose breath is 7 deg. 45 min.

2 The second passing through Syene, beginneth in the latitude of 20 deg. 30 min. & endeth in 27 deg. 30 min. whose breadth is 7 deg.

3 The third passing through Alexandria, beginneth in the latit. of 27 deg. 30 min & endeth in 33 deg. 40 min, whose breath is 6 deg. 10 min.

4 The fourth passing by Rhodes, beginneth in the latitude of 33 deg. 40 min. & endeth in 35 deg. whose breadth is 5 deg. 20 min.

5 The fifth passing by Rome, beginneth in the latitude of 39 deg. and endeth in 43 deg. 30 min. whose breadth is 3 deg. 45 min.

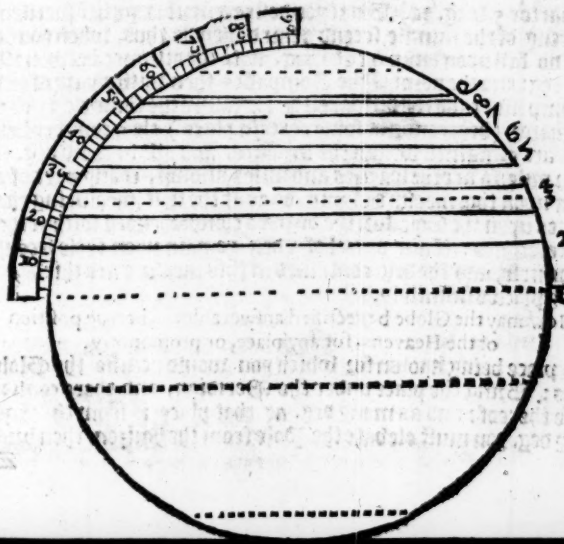
6 The sixth passing by Boristhines, beginneth in 43 deg. 30 min. and endeth in 47 deg. 15 min. whose breadth is 3 deg. 45 min.

7 The seventh passing by the Riphæan mountains, beginneth in 47 deg. 15 min & endeth in 50 deg. 20 min. whose breadth is 3 deg. 5 min.

8 The eighth passing by Mæotis, or London, beginneth in 50 deg. 20 min. and endeth in 52 deg. 10 min. whose breadth is 2 deg. 50 min.

9 The ninth passing by Denmark, taketh his beginning in the latit. of 53 d. 10 m. & endeth in the lat. of 55 d 30 m. & hath in breth 2 d. 20. m.

If you desire to know how many leag. every climate is in breth, allow for every deg. 20 leag. or 60 miles, & for every min. a mile, so is the distance given. Thus have I manifested unto you all the divisions and particularities of the Spheres distinction.



What is the use of the Globe?

THe use of the Globe is of so great ease, certainty, & pleasure, as that the commendations thereof cannot sufficiently be expressed, for of all Instruments it is the most rare and excellent, whose conclusions are infallible, giving the true line, angle, and circular motion of any Course or Travers that may in Navigation happen, whereby the longitude and latitude is most precisely known, & the certainty of distance very plainly manifested according to the true nature thereof: it giveth the variation of the Compass, and the hour or time of the day at all seasons, and in all places. And by the Globe, the Poles height may at all instants, & upon every point or Azumuth of the horizon by the Suns altitude taken, be most precisely known, by the certainty of whose excellent use the skilful Pilot shall receive content in his pleasing practise gubernautick.

How are distances measured upon the Globe?

WHen there are two places assigned, the distance between which you desire to know, with a pair of circular Compasses you must do it in this sort: set one foot of the Compasses upon one of the places, & the other foot upon the other place, the Compasses so stretched forth, bring unto the Equator, and as many degrees as may be contained between those two points of the Compass, allowing 20 leagues for every degree, is the distance desired: or if the places be of such distance as that you cannot with your Compasses reach them, then take with your Compasses 5 deg. of the Equator, which is 100 leag. or 10 deg. for 200 leag. and so measure how often the distance is contained between the said places, if any part of a Degree doth remain, for half a deg. allow 10 leag. for a quarter 5 leag. &c. But if you desire a most exquisite preciseness in measuring of the minute, second & third, then do thus, when your Compasses do fall upon any part of a deg. note the distance between the end of that deg: and the point of the Compasses, then with a pair of convenient Compasses take the distance, then measure the same 60 times upon the Equator, (beginning at some certain place) then consider how many deg. are contained within the measure, and allow every deg. to be a min. or mile, so are the leagues and miles known, if any part of a deg. remain upon this measure of min. do as at the first, measuring the same 60 times upon the Equator, the degrees comprehended within the measure, are seconds: if any parcel of a deg. remain upon these seconds, do as in the first, and the deg. contained in this measure are thirds, and so you may proceed infinitely.

How may the Globe be rectified answerable to the true position of the Heavens, for any place, or promontory.

THe place being known for which you would rectifie the Globe, do thus: Bring the place under the Meridian, and there consider the latitude thereof: and as many deg. as that place is from the Equator, so many deg. you must elevate the Pole from the horizon, then bring the

Zenith

Zenith directly over the ſame place, & ſo is your Globe rectified for the execution of any practiſe: and without this ordering of the Globe, there is no concluſion to be executed by the ſame.

How is the Longitude of places known by the Globe?

BY turning the Globe within the Meridian, you muſt bring the Promentory, Bay, Harborow, City, or other place (whoſe latitude and longitude you ſeek) preciſely under the Meridian, there holding the Globe ſteady, the degree of the Meridian that is directly over the ſaid place, ſheweth the latitude thereof, and that degree of the Equinoctial which is directly under the Meridian is the longitude of the ſame place.

How is the Corſe found between place and place?

TWo places being aſsigned the Corſe between which you deſire to know, firſt ſeek the latitude of one of theſe places, & rectifie the globe anſwerable unto the ſame, as before is taught, then bring that place directly under the Meridian & Zenith, if both places be under your Meridian, they then lye North and South, if not then, bring the Quarta altitudo to the other place, and note upon what part of the horizon the end of the ſame toucheth, for that is the preciſe horizontal Corſe between the ſaid places; but this you muſt conſider, that the horizontal Corſe is not the Navigable Corſe, unleſs the places be of ſmal diſtance, for if any place bear northeaſt from me, or eaſt from me, or upon any other point, North or South excepted, and be diſtant 500 leagues, if I ſayl upon the Horizontal Corſe, I ſhall never arive unto the ſame place.

How then ſhall the Pilot ſail by the Globe, if the matter be ſo doubtful?

THe skilful Pilot that uſeth this excellent Inſtrument, doth firſt conſider the place from whence he ſhapeth his Corſe, and rectifieth the Globe anſwerable to the ſame, then bringing the place directly under the Meridian and zenith, there holding the globe ſteady, bringeth the quarta altitudo to the place for which he is bound, the end whereof ſheweth upon the Horizon the true horizontal Corſe, upon which Corſe he ſailleth 20 or 30 leagues, and there maketh a note or prick by the edge of his Quarta altitudo, according to the true diſtance proved by corſe, reckoning an altitude as in the uſe of a Chart: then he bringeth that prick or note under the Meridian, and there conſidereth the true latitude of his being, he then rectifieth the Globe anſwerable to the ſame prick, and keeping the ſame under the Zenith, doth again turn to the quarta altitudo, to the place for which he is bound, the end whereof ſheweth upon the Horizon the horizontal corſe, then ſayling as at the firſt, he maketh a note or prick as before, and thus proſecuting his Corſe, ſhall arive unto his deſired place: but in this practiſe he ſhall plainly prove that his horizontal corſe will differ greatly, and that by his ſayling in this ſort, he ſhall by his notes and pricks deſcribe the true Navigable & neereſt Corſes between the ſaid places: The like Method is to be obſerved upon any travers or forced courſe whatſoever: and therefore the Pilot muſt take care, that

although the wind be never so favourable, yet he must not prosecute any Horizontal Course (North and South only excepted.)

Therefore I say, the Pilot must take special care to consider the distance of places, whether the Horizontal Course will lead him between the said places: for if places be more than 45 degrees asunder, the horizontal Course is not the mean to finde those places: unless they lye North and South: for the horizontal course between any two places, is a portion of a great Circle, which being of large distance, must be performed by a great circle Navigation, and not by Horizontal courses: for the collection of many Horizontal Courses being knit together, do perform a Paradoral motion, altogether differing from a great circle: as for example: Being at Cape verde, there is a place distant from me 80 deg. upon the point Northwest, unto which place I desire to sayl, I therefore bring Cape verde, under the Meridian of my Globe, there considering the latitude of the Cape, I raise the Pole answerable to the same, and place the Zenith directly over the Cape, then turning the quarta altitudo to the point northwest upon the horizon all such places as the said quarta altitudo then toucheth, do bear due Northwest from me now prosecuting this Course by the direction of my Compass, the first day I sayl 20 leag. therefore I make a mark by the edge of the quarta altitudo 20 leag. from the Zenith, then bringing that mark under the Meridian I rectifie the Globe answerable to the latitude thereof, the next day I sayl other 20 leagues upon the same point, and make a mark as at the first. I bring that mark likewise under the Meridian, and rectifie the Globe as before, and by this Method prosecuting the Course N. W. I shall describe a paradoral line, which will lead me to the North of the place unto which I would sayl, the farther the distance, the greater the difference: by this Order you may describe paradoral lines upon all the points of the Compass, but this is to be regarded, that your differences be as small as you may, and that none of them exceed 20 leagues, for by the smallest distinctions, is performed the greatest certainty. And by the description of these lines you may very manifestly understand the difference of Horizontal, Paradoral, and great Circle Navigation.

And this may suffice for the sayling use of the Globe, convenient for the Seamans purpose.

What is the great Circle Navigation?

GReat Circle Navigation is the chiefest of all the 3 kinds of sayling, in whom all the other are contained, and by them this kind of sayling is performed, continuing a Course by the shortest distance between places, not limited to any one Course, either horizontal or paradoral, but by it these Courses are Ordered to the full perfection of this rare practise, whose benefits in long Voyages are to great purpose, ordering and disposing all horizontal traberses to a perfect conclusion: for there are many changes of horizontal and paradoral Courses in the execution of this practise, so that upon the shifting of a wind, when that it may seem that

you

you are forced to an inconvenient course by the skill of great Circle sayling, that course shall be found the shortest and only proper motion to performe your voyage. And also when with favourable winds the pilote shall shape a Course by his Chart or Compasse paradorall, as the best meane to attaine his Port, he shall by this kinde of sayling finde a better and shorter Course, and by sufficient demonstration prove the same, so that without this knowledge I see not how Courses may be ordered to their best advantage: therefore sith by it the perfection of sayling is largely understood, and the errour likewise most substantially controled, it may of right challenge the chiefest place among the practises Gubernatik. The particularities whereof if I should by an orderly method labour to expresse, it would be a discourse over-large for this place, as I think troublesome if the premises be not well understood: therefore I will now over-pass it, until a time more convenient, and of better leasure.

Of Paradoxal Navigation.

PAradoxal Navigation, demonstrateth the true motion of the ship upon any Course assigned, in his true nature by longitude, latitude, and distance, giving the full limit or determination of the same, by which motion, lines are described neither circular nor strait, but concurred or winding lines, and are therefore called paradoxal, because it is beyond opinion that such lines should be described by plain horizontal motion: for the full perfection of which practise I purpose (if God permit) to publish a paradoxal Chart, with all convenient spæd and so will discover by the same at large all the practises of paradoxal and great circle navigation, for upon the paradoxal Chart, it will best serve the Seamans purpose, being an instrument portable, of easie stowage and small practise, performing the practises of Navigation as largely and as beneficially as the Globe in all respects: and all these practises of sayling before mentioned, may in a general name be aptly called Navigation geometrical, because it wholly consisteth of Geometrical demonstrative conclusions.

But there is another knowledge of Navigation, which so far excelleth all that is before spoken, or that hath hitherto been vulgarly practised, as the substance his shadow, or as the light surpasseth the thick obscured darkness: and this sweet skill of sayling may well be called Navigation arithmetical, because it wholly consisteth of calculations, comprehended within the limit of numbers, distinguishing courses not only upon the points of the compass, but upon every degree of the horizon, and giveth the distance of any Travers for the particular elevation of minuts, yea, and less parts assure your self: it giveth longitudes and latitudes to the minute, second, and third: in so great certainty, as that by other means the like cānot be performed: it teacheth the nature of angles and triangles, as well spherical as plain superficial and solid commensurations, the effect of lines strait, circular, & paradoxal, the quantities

and proportions of parallels, the nature of Horizons, with every particular distinction of any alteration whatsoever, that may in Navigation be required to a most wonderful precise certainty: for there can nothing be required, that by this heavenly harmony of numbers shall not be most copiously manifested to the Seamans admiration & great content: the orderly practise whereof, to the best of my poor capacity, I purpose to make known, if I may perceive my pains already taken, to be received in good part, which I distrust not but all honest-minded Seamen & Pilots of reputation will gratefully embrace, only in regard of my friendly good will towards them, for it is not in respect of my pains, but of my love, that I would receive favourable curtesie.

How may the Poles height be known by the Globe?

THere are divers ways to find the Poles height by the Globe, as well from the Meridian as upon the same, but sith before I have sufficiently taught how by the Suns Meridian Altitude, the Poles height may be found, I will therefore in this place speak no further therof, but for the other kinds it may be known as followeth:

How by the Suns Rising or Setting, the Poles height may be known.

BY your Compass of variation or some magnetical instrument, observe at the Sun rising, upon what degree of the Horizon the Center toucheth according to the true horizontal position of the Magnet, all variation duly considered, that being known, search in the Tables of the Ephimerides, for the Suns place in the Ecliptick, at the time of your observation, then bring that place or degree of the ecliptick wherein you find the Sun to be to the Horizon, and move the Meridian of the Globe as occasion requireth, until that observed degree of the Horizon and the Suns place in the Ecliptick do justly touch together, for then is the Pole in his due Elevation, as by the intersection of the Horizon and Meridian may appear, in like sort you may find the Poles Altitude, by any known fixed Star in the Horizon.

To find out the Poles height by the Sun, upon any point of the Compass.

BY the Compass of variation, rectified to the true horizontal position observe the Sun until he come to any point therof at your pleasure, and in the same instant take the Suns height from the horizon, then bring the quarta altitudo to that point of the Compass upon the horizon of the Globe where you observe the Sun to be, there holding the quarta altitudo steady, move the Globe until you bring the degree of the Ecliptick (wherein the Sun is at the time of your observation) unto the edge of the quarta altitudo, if it fall upon that degree of Altitude as was the Suns observed height, then doth the Pole stand to his true Elevation, but if it agree not, you must elevate or depress the Pole as occasion requireth, rectifying the Zenith answerable thereunto. And again, make tryal as at the first, bringing the place of the Sun to the

quarta

quarta altitudo, and setting the same upon the observed point of the Compass, until it agree in all respects with your observation, and then the Meridian sheweth in his intersection with the Horizon, the elevation of the Pole from the Horizon.

To find the Poles height by any given Azumuth by the Sun being above the Horizon

By your Magnetical Instrument, or Compass of variation, observe the Azumuth of the Sun at any time in the forenoon, or afternoon, the nearer the Sun is to the horizon, the better shall be your observation, and at the same instant take the height of the Sun from the horizon, keep these two numbers in memory, and note that the Azumuth be observed according to the true position of the horizon, by having good regard to the variation of the Compass, then bring the quarta altitudo to the place of the Sun in the Ecliptick, and set that degree of the Suns place in the Ecliptick upon the observed degree of Altitude by the graduation of the quarta altitudo, and if the end thereof at the same instant do fall right upon the observed deg. of Azumuth, then is the Pole in his due elevation: if not, then raise or lay the Pole as occasion requireth, alwaies regarding that you place the Zenith answerable to the Poles altitude, & then again bring the Suns place to his altitude upon the quarta altitudo, and look again whether the end thereof do touch the observed deg. of the Azumuth upon the horizon, if not, you must prosecute this order, until at one instant the place of the Sun be upon his true Almicanter, by the edge of the quarta altitudo, & that the end of the quarta altitudo do also touch the observed deg. of Azumuth upon the horizon, for then is the Pole in his true elevation, as by the Meridian and the Horizon will appear.

To find the Poles height by the Sun, by any two given Azumuths, & Altitudes, not regarding the true horizontal position, or needless variations.

Because there may great errors be committed in the former observations, unless the Compass be perfectly well rectified, so as it may respect the true parts or distinctions of the horizon, it is not amiss to inform you how without regard of variation, the poles height may be found.

Therefore by your Magnetical instrument or Compass of variation, observe the Suns Azumuth, without regard of the true horizontal position, and at the same instant observe also his Altitude from the horizon, keep those two numbers in memory, then after the Sun hath moved a point or two points of the Compass more or less at your discretion, observe again his Azumuth and Altitude as at the first, then consider the ark of the Horizon, through which the Sun hath moved between these two Observations, for by the two Observations of the Suns Altitude and by the degrees of Azumuth through which the Sun hath moved, the Poles height is thus known: First, set the Globe to the Elevation of the place wherein you are as near as you can ghess, and

bring

bring the Zenith to the like latitude from the Equator, as the poles elevation is from the horizon, then bring the quarta altitudo to the place of the Sun upon the ecliptick, for the time of your observation, there place the Sun upon the first observed altitude by the degrees of the quarta altitudo, and not the degree of the Horizon which the quarta altitudo then toucheth: this done, bring the Suns place to the second observed altitude, by touching the quarta altitudo of the globe until the degree of the Suns place in the ecliptick, and the degree of his altitude upon the quarta altitudo do meet. Then again consider the degrees of the horizon, which the end of the quarta altitudo toucheth, and note the ark of the Horizon contained between your two Observations, of how many degrees it consisteth, if it agree with the observations made by your Magnetical Instrument, then doth the Pole stand in his true altitude, if not, you must either raise or depress the Pole, and again prosecute the former practise, until you finde such Azumuths and Altitudes upon the Globe, as you found by your Magnetical observations, for then the Pole doth stand in his true altitude, and then doth also appear the true Azumuth of both your observations, which if it agree not with your Compass, then is your Compass varied, and may hereby be corrected, so that this doth not only give the poles height, but also the true horizontal position without errour.

To find the Poles height by taking the Suns altitude above the Horizon, so that the precise time of any such Observation be known.

IF you desire at any time of the day to know the Poles height, as at 8, 9, or 10 of the clock, &c. mark diligently the time of your observation, at what instant you do observe the Suns altitude from the horizon, the time and altitude thus known, bring the place of the ecliptick wherein the Sun is at the time of your observation directly under the Meridian, there holding the Globe steady, bring the Inder of the Circulus horarius to the hours of 12, or noon, then move the Globe until the Inder come to the hour of your observation, there hold the Globe steady, then bring the quarta altitudo to the place of the Sun in the ecliptick, if it agree with your observed altitude, then doth the Pole stand in his true Elevation, if not, move the Meridian by raising or depressing the pole as occasion requireth, until you bring the altitude and the hour to agree, and then you have the Poles height, and by the end of the quarta altitudo doth also appear the degree of Azumuth, whereupon the Sun was at the time of your observation, and note that in raising or depressing the Pole of the Globe, you must also place the Zenith so far from the Equinoctial, as the Pole is from the Horizon; for this is a general rule, that so much as the Pole is elevated from the Horizon, so much is the latitude of the Zenith from the Equator, therefore you must alwayes bring the Zenith and Altitude to agree, whensoever you alter the elevation, be it never so little.

To

To find the Poles height by any two obſervations of the Suns Altitude, not regarding the hour of the day, or any horizontal poſition of the Magnet, ſo that you know the diſtance of time between the ſaid Obſervations.

ALthough there be ſome difficulty in giving the true time of any obſervations at the Sea, by reaſon of the alterations of Horizons, and of the needleſs variation, yet it is a matter moſt eaſie by a good hour-glaſs, half-hour-glaſs, and minute-glaſs, to meaſure the diſtance of time between any two obſerved altitudes, you may therefore upon that ground find the poles height with great facility at any time, by the Sun or any fixed Star, in this ſort:

Conſider in what place of the Ecliptick the Sun is at any time of your Obſervation, bring that place to the Meridian, there with a black Lead, by moving the Globe, deſcribe a parallel to the Equator, anſwerable to the Suns diurnal motion and declination for the ſame inſtant, then if between your Obſervations there be an hour, two hours, more or leſs at your pleaſure, as by your running glaſſes may be known, you muſt allow for every hour 15 degrees of the Equator for ſo much aſcendeth every hour, and for every 4 minutes one degree, and for every min. $\frac{1}{4}$ of a degree, then knowing by this Order how many degrees the Sun is moved between your two Obſervations, you muſt upon the parallel which you drew make two notes, ſo many degrees aſunder as the Sun hath moved between your Obſervations, which may be done in this ſort: bring the place wherein the Sun is under the Meridian, and mark what degree of the Equator is then under the Meridian, the Globe ſo ſtanding upon your Parallel cloſe by the Meridian, make the firſt note or mark, then turn the Globe, and reckon the degrees of the Equator that paſs under the Meridian, until ſo many be paſt as was your Obſervation, there again hold the Globe ſteady, and upon your parallel cloſe by the Meridian make your ſecond note or mark, then knowing the Suns altitude at both the Obſervations, you muſt bring the quarta altitudo, to the firſt note made upon your parallel, there holding the Globe ſteady, the quarta altitudo, and mark agreeing in altitude, bring the quarta altitudo to the ſecond note, if that do alſo agree with your former obſerved altitude, then doth the Globe ſtand in his true Elevation, if not, you muſt elevate or depreſs the Pole by diſcretion, until you bring the two obſerved altitudes of the Sun to agree with the two marks which you made upon your deſcribed parallel, and then is the Pole at his true elevation: and what is ſpoken of the Sun, the like may be done by any known fixed Star. I hold this concluſion to be very neceſſary, pleaſant, and eaſie for the Seamans purpoſe.

To

To find the true place of the Sun in the Ecliptick at all times.

BEcause it is most necessarily required in the former practises, that the Suns true place in the Ecliptick be at all times known, I think it not amiss to inform you how the same may be done.

The chiefest and most certain mean to know the same, is by the Tables of the Ephemerides, but those Tables wanting, the Seaman may in this sort do it: By the Regiment seek out the declination of the Sun, that being known, bring the Zenith upon the Meridian, so many deg. and minuts from the Equator as is the Suns declination, then move the Globe until some deg. of the Ecliptick do come directly under the point of the Zenith, for that is the Suns place: you must further consider, whether it be betwæn March and June, for then you must find the deg. in that quarter of the Ecliptick, contained betwæn Aries and Cancer: if it be betwæn June and September, you must find the deg. in that quarter of the Ecliptick, contained betwæn Cancer and Libra, &c. of the rest.

It may also be known upon the Horizon of the Globe by a Calender Circle that is there described, in this sort: First, search the day of your Month wherein you desire to know the Suns declination, and directly against the same degrée which standeth for that day, doth also stand the degrée of the Zodiack wherein the Sun is at the same time, in a Circle representing the Zodiack, and described upon the Horizon.

But if it be Leap-year, you must not take the precise day of the Month wherein you sée the Suns place, but the next day following, and against that day seek the declination.

To find the Poles height by any two known fixed Stars.

WHen you sée any two fixed Stars, which you know to be both at one instant in the Horizon, upon your Globe search for those Stars, and bring one of them to touch the Horizon of the Globe, if the other do not likewise touch the Horizon, you must raise or depress the Pole by discréet moving of the Meridian, until you bring both those Stars to be at one instant in the Horizon, for then the Globe doth stand to his true Elevation.

To find the Poles height by any two known fixed Stars another way.

WHen you sée any fixed Star that you know to be in the Horizon, you must presently take the height of some other Star, that you likewise know, before the first be risen from the Horizon, then upon your

your Globe ſearch for the Star that you obſerved in the horizon of the Globe, there holding the Globe ſteady, bring the quarta altitudo to the other Star whoſe altitude you obſerved, if it agree upon the quarta altitudo with the obſerved altitude, then the Globe doth ſtand to his true elevation; if not, you muſt by diſcretion raiſe or lay the Pole, until you find the one Star in the horizon, and the other upon his true obſerved altitude, for then the Pole doth ſtand to his true elevation.

To find the Poles height at any time by any two known fixed Stars.

WIth your Croſs-ſtaff take the diſtance of any two Stars from your Zenith, which muſt be done with as much expedition as may be, their diſtances ſo known, with a pair of Compaſſes, meaſure ſo many degrees upon the Equator, as is the diſtance of the firſt obſerved Star, with another pair of Compaſſes do the like for the ſecond obſerved Star, upon the firſt Star ſet one point of the Compaſſes that took his diſtance, and upon the ſecond Star ſet likewiſe one foot of the Compaſſes that took his diſtance, bring the other two feet of the Compaſſes to meet together, there make a mark, for that is the parallel wherein you be, that mark is the Zenith, bring it to the Meridian by moving the Globe, and there will appear the latitude deſired, for ſo many degrees and minuts as that mark is from the Equator, ſo much is the Pole elevated above the Horizon. This concluſion the Seaman ought to have in good eſteem.

To know the preciſe hour at all times by the Sun.

FOr the finding of the hour of the day by the Globe, it is neceſſary that the Poles height be firſt known, therefore ſet the Pole to his true Elevation, and the Zenith to his anſwerable latitude, then bring the place of the Sun in the Ecliptick under the Meridian, there holding the Globe ſteady, place the Inder of the Circulus horarius upon 12. of the clock, or noon, your Globe thus ordered, then with your Croſs-ſtaff take the Suns height from the Horizon, that being known you muſt bring the place of the Sun to the quarta altitudo, by moving the Globe and quarta altitudo until the place of the Sun do agree with the obſerved altitude, there holding the Globe that he move not, the Inder doth ſhew upon the Circulus horarius, the true hour deſired.

To find the Hour of the Night by any known fixed Star.

SEt the Globe to his true Altitude, and the Zenith to his answerable Latitude, you must also place the Index of the Circulus horarius upon the hour of 12. or noon, by bringing the Suns place under the Meridian. &c. as before you did by the Sun, then take the height of any known fixed Star, bring that Star to the quarta altitudo, by moving the Globe and quarta altitudo, until the Star come to his true observed Altitude, there holding the Globe steady, the Index doth shew upon the Circulus horarius, the true time of your Observation.

To know the length of the Dayes and Nights, at all times, and in all Places.

THe place and time being given wherein you desire to know the length of the day or night, first set the Globe to his Altitude for the place, then search the place of the Sun in the Ecliptick, for the time wherein you seek the dayes length, bring that place of the Sun under the Meridian, there holding the Globe that he move not, place the Index of the Circulus horarius upon the hour 12, or noon. then turn the Globe until you bring the place of the Sun to touch the East part of the Horizon, there holding the Globe, you shall see by the Index of the Circulus horarius, the true time of the Suns Rising, then bring the place of the Sun to the West part of the Horizon, and you shall there see the true time of the Suns setting, whereby the length of the day and night doth most plainly appear. And this may suffice for the use of the Globe, necessary for the Seamans use.

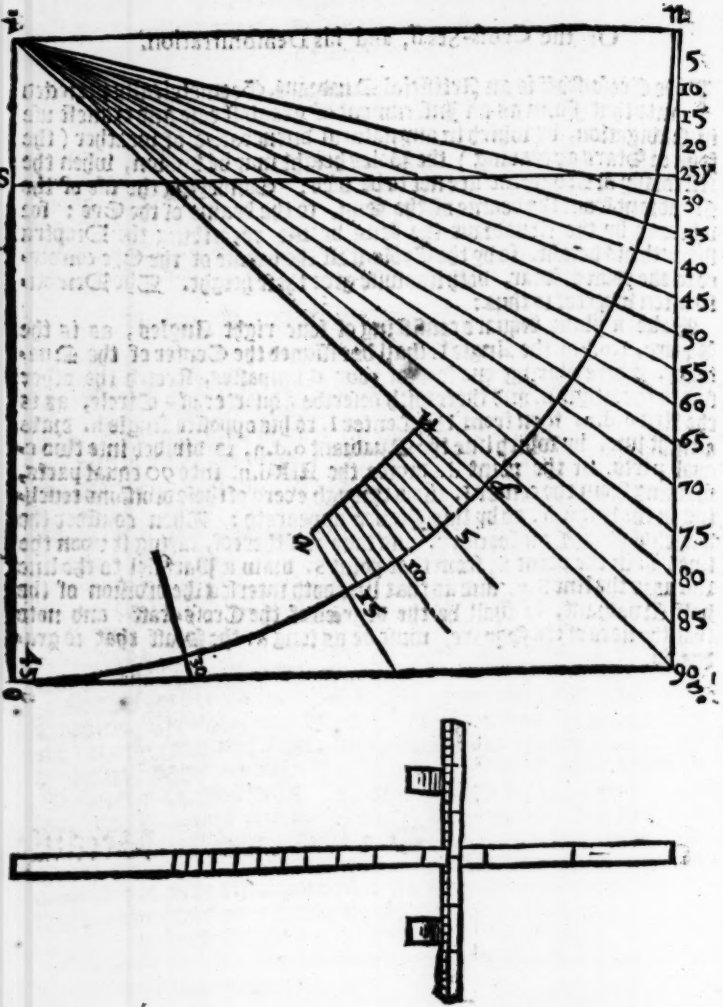
I might here recite the Triple Rising and Setting of the Stars, Cosmice, Acronice, and Heliace, the ascentions right and oblique, the dawning and twy light, hours equal and unequal, ordinary and planetary, dayes natural and artificial, the triple rising of the Sun, Equinoctial and Solsticial, Circles of Position with their use and nature the Horiscope and domifying distinctions of the Heavens, the Planets, their Motions, Retrogradations, and Excentricitie of their Orbs, Horologie, and many other most pleasant conclusions: but because they do in no sort appertain to the Seamans use, I therefore omit them, as matters more troublesome than profitable for him, expecting from some learned Mathematician a work of worthy esteem, wherein these, and many other excellent Conclusions, shall by cunning Demonstration be made known unto us.

OF

Of the Crosſ-Staff, and his Demonſtration.

The Croſs-ſtaff is an Artificial Quadrant, Geometrically projected into that Form as an Inſtrument of greateſt eaſe and exacteſt uſe in Navigation, by which in any natural diſturbance of weather (the Sun or Stars appearing) the Poles height may be known, when the Aſtrolabe or Quadrant are not to be uſed: Conveying the uſe of the Quadrant from the beame of the Sun, to the beams of the Eye: for whereas by the Quadrant the Sun beame perceiving the Dioptra sheweth his height, ſo by the Croſs-ſtaff the beame of the Eye conveyed to the Sun or Star, doth likewiſe give their height. The Demonſtration whereof is thus:

Make a plain Square conſiſting of four right Angles, as is the Square, I.o.h.n. the Angle I. ſhall be aſſigned the Center of the Quadrant, where placing one foot of your Compaſſes, ſtretch the other foot to the Angle n. and therewith deſcribe a quarter of a Circle, as is the Ark o.d.n. then from the Center I. to his oppoſite Angle h. draw a right line, by which line the Quadrant o.d.n. is divided into two equal parts, in the point d. divide the Ark d.n. into 90 equal parts, drawing from the center I. lines through every of thoſe diviſions touching in the line n.h. as by this Figure appeareth: Then conſider the length of your Tranſverſary, and take half thereof, laying it upon the line I.o. in the point S. from that point S. draw a Parallel to the line I.n. as is the line S.y. and as that line doth interſect the diviſion of the half Quadrant, ſo ſhall be the degrees of the Croſs-ſtaff; and note that the ſides of the Square, muſt be as long as the Staff that is graduated.



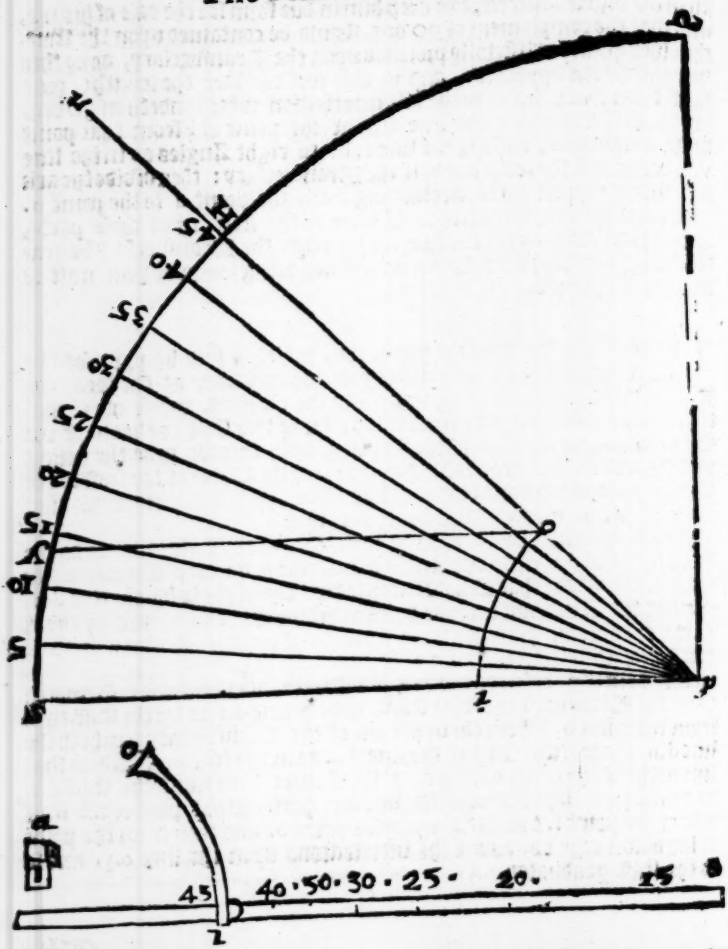
Becauſe the ſtaff ſhould be of unreaſonable length to contain more than

than 60 degrees, therefore to keep him in due form for the ease of his use, and that the complement of 90 deg. should be contained upon the staff, the other 30 are artificially projected upon the Transversary, as by this demonstration appeareth, and in this sort consider the length of your staff from that point s. to the last intersection which endeth in 30 deg. lay down the length of the line I. h. at the point of v from that point draw a right line, cutting the line I. h. to right Angles as in the line v. a. being just the length of half the Transversary: then divide the ark o. d. into 45 equal parts, accounting from the point d to the point o. then from the Angle I. draw right lines to the first 15 of those parts, and as those lines do cut the line v. a. so must the Transversary be graduated on both his parts, whereunto vanes being framed, your staff is finished to your use.

THere is a staff of another projection, which I find by practise to be an Instrument of very great ease and certainty at the Sea, the Sun not being more than 45 deg. above the Horizon, whose use is contrary to the other before demonstrated, for by this staff the beam of the Sun shadowing upon the Transversary, doth thereby give the height most precisely, not regarding how to place the center of the staff to the Eye, for the correction of the parallax of the sight, and without looking upon the Sun, whose demonstration is thus:

Draw two right lines, cutting each other at right Angles, as do the lines d. v. and d. s. upon the Angle d. describe a quarter Circle, as is the ark v. s. divide that Quadrant into two equal parts by the line d. n. cutting the Quadrant into the point h. divide the ark s. h. into 45 equal parts or degrees, drawing lines from the Center d. to every of those divisions, then from the point I. bring the third part of the line d. s. upon the Center d. describe the ark of a Circle, as is the ark I. o. which is for the Transversary of this staff, and the line d. s. is for the staff, then from the point o. where the upper end of the Transversary toucheth the line d. n. draw a Parallel to the line d. s. as in the line o. y. and as that line doth cut the lines, drawn from the Center d. so must the staff d s. be graduated, laying it upon the line o. y. putting that part of the staff where the point I. toucheth, upon the point o. and then from the point I. lay down degrees, as are the intersections upon the line o. y. and so is the staff graduated.

The

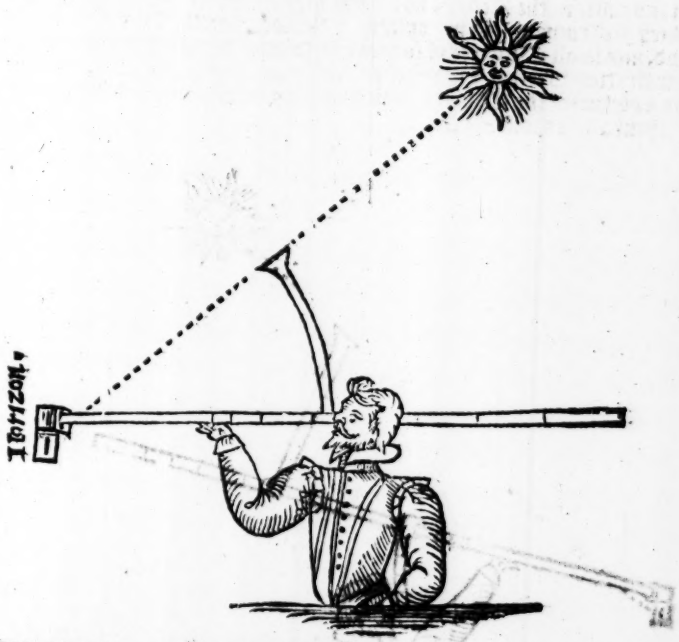


The transversary at the point i. must have an artificial hole made for the staff to run in, as other staves have, also there must be a plate of brass with a foccat to be set to the center of the staff, as is the Figure a. in the midst whereof there must be a slit, through which the light must be conveyed to the Horizon, and this plate must receive the shadow of the transversary, and so the staff is finished.

How

How is the uſe of this Staff?

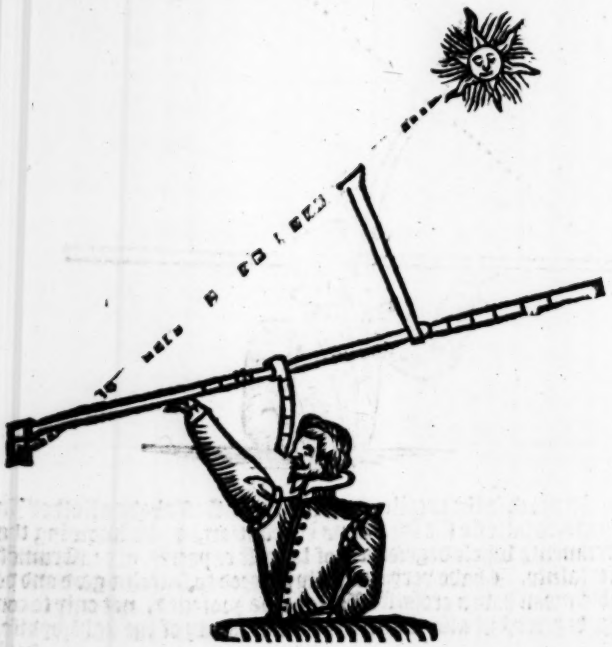
THe uſe of this ſtaff is altogether contrary to the other, for the center of this ſtaff where the braſs plate is faſtned, muſt be turned to that part of the horizon which is from the Sun, and with your back toward the Sun, by the lower edge of the half croſs, and through the ſlit of the plate you muſt direct your ſight only to the Horizon, and then moving the Tranſverſary as occaſion requireth, until the ſhadow of your upper edge of the Tranſverſary do fall directly upon the ſame ſlit or long hole, and alſo at the ſame inſtant you ſee the Horizon through the ſlit, and then the Tranſverſary ſheweth the height deſired.



FInding by practiſe the excellency of the croſs-ſtaff above all other Inſtruments, to ſatisfie the Seamans expectation, & alſo knowing that thoſe inſtruments whoſe degrées are of largeſt capacity, are inſtrumẽts of moſt certainty. I have very carefully labored to ſearch a good and demonſtrable mean how a croſs-ſtaff might be projected, not only to contain large degrées, but alſo to auoid the uncertainty of the ſight, by diſorderly

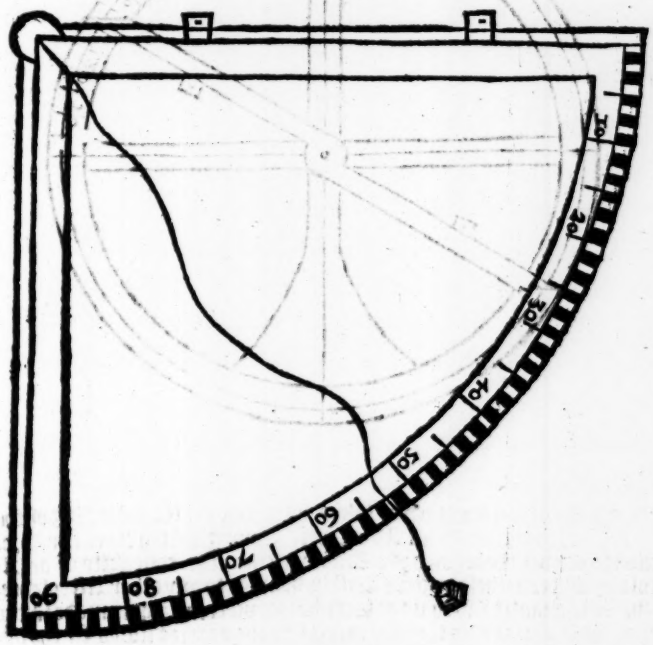
perly placing of the staff to the eye, which demonstration I have found, and have had the Instrument in practise, aswel under the Sun, as in other Climates. but because it hath a large demonstration, with manifold uses, I here omit to manifest the same, purposing to write a particular Treatise thereof, notwithstanding his Form and use, by picture I have thought good to express.

THis staff is a yard long, having two half crosses, the one circular, the other strait, the longest not 14 inches, yet this staff doth contain the whole 90 degrees, the shortest degree being an inch and ¾ long, wherein the minuts are particularly & very sensibly laid down, by which staff not regarding the parallax of your sight, nor looking upon the Sun, but only upon the Horizon, the Suns height is most precisely known, aswel and as easily in the Zenith, as in any other part of the heaven. As which Instrument (in my opinion) the Seaman shall not find any so good, and in all Climates of so great certainty, the Invention and demonstration whereof I may boldly challenge to appertain unto my self (as a portion of the Talent which God hath bestowed upon me) I hope without abuse or offence to any.



Of the Quadrant.

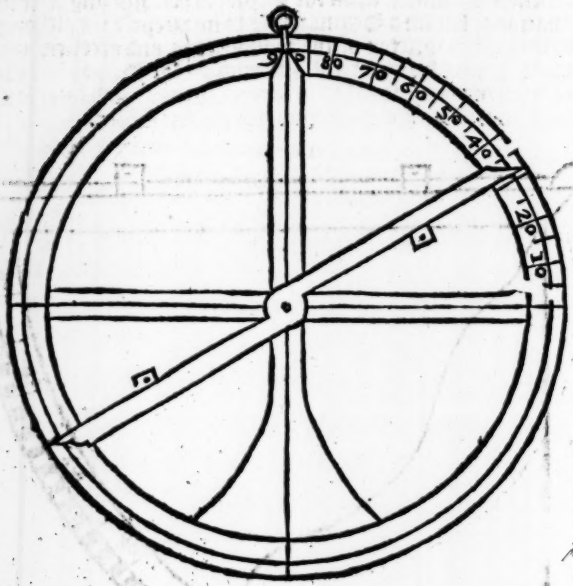
A Quadrant is the fourth part of a Circle, containing 90 degrées, and repreſenteth the diſtance betwéen the Horizon & Zenith, being an excellent Inſtrument upon the Shore, to perform any Aſtronomical Obſervations, but for a Seaman it is to no purpoſe: & although there may be very much written of the commodious and excellent uſes of the Quadrant, yet not being an apt Inſtrument for Sea-obſervations, it ſhall be from my purpoſe to write further thereof, and therefore the only laying down of his Form, may at this preſent ſuffice.



Of the Aſtrolaby.

AN Aſtrolaby is the repreſentation of a great circle, containing four Quadrants, or 360 degrées, which Inſtrument hath been in long uſe among Seamen, and it is an excellent Inſtrument, being rightly underſtood and operated; but with the vulgar Aſtrolaby with his uſe to

every Seaman sufficiently known, it should be vain labor for me to lay down his use and demonstration: Therefore by his Form it shall suffice to express him.

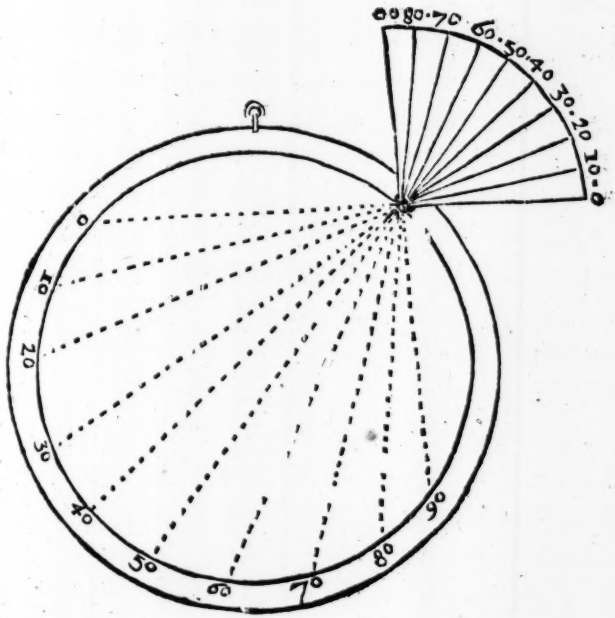


There hath been great pains taken by many, for the enlarging of the degrees contained in an Astrolabie, among which there is a Projection to convey the degrees of a Quadrant into the concavity of an Astrolaby whereby these degrees shall be double, to any other Astrolabie, of the same quantity, so that the Sun-beam, piercing a hole made in the side of the Astrolaby, is thereby carried to the degrees noted in the opposite concave part, as by his Form may appear.

Also my self laboring in the same matter, have found a mean whereby an Ark of a Quadrant, whose side is 10 foot, may be conveyed into an Astrolaby of 10 inches diameter, whose Dioptra shall cut his limb to right angles, and shall perform the complement of 90 degrees, as amply and as effectually as by the Quadrant it may in any sort be done.

Whose

Whose demonstration, together with the demonstration of my Staff, I purpose (God willing) at large to manifest: But there can be no Invention that can establish the certainty of the use of either Quadrant or Astrelaby at the Sea, for unless it be in very smooth water, there can be no certainty of any observation by those Instruments, whereby the Seaman may rest assured of the Altitude which he seeketh, but the Observations made by the Cross-staff, are without all distrust of error, and therefore no Instrument may compare with the excellencie of this Cross-staff for the Seamans use.



FINIS.